5-3486/

Canadian Cataloguing in Publication Data

Main entry under title:
Environmental description and assessment of the proposed Rupert-Grassy Point transmission line

Bibliography: p.
ISBN 0-7719-9164-9

1. Electric lines - Environmental aspects - British Columbia - Prince Rupert region. 2. Electric power transmission - Environmental aspects - British Columbia - Prince Rupert region. I. Tera Environmental Consultants Ltd. II. B.C. Hydro. III. Dome Petroleum Limited.

TD195.E37E56 333.73'1'0971132 C83-092092-7

ENVIRONMENTAL DESCRIPTION AND ASSESSMENT OF THE PROPOSED RUPERT-GRASSY POINT TRANSMISSION LINE

Prepared by:

TERA Environmental Consultants Ltd.

Prepared for:

B.C. Hydro and Power Authority

Dome Petroleum Limited

January, 1983.

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SUMMARY

The report presents environmental studies for a proposed 230 or 287kV transmission line from the Prince Rupert Substation to Grassy Point, 30 km north of Prince Rupert. The line would service Dome Petroleum's Western Liquefied Natural Gas (LNG) Project, to be constructed at Grassy Point.

Eleven corridor segments were examined in the course of the study. (Fig. 2-1). Different combinations of these segments provide 12 alternative routes for the transmission line. Each corridor segment was examined in terms of terrain, vegetation, water resources, fish, wildlife, land use and settlement, forestry, visual quality, recreation, and heritage resources. An inventory of these environmental features was developed for each segment, and examined for sensitive areas that could constrain transmission line routing. Potential impacts were anticipated and mitigation measures proposed to reduce adverse effects of constructing and operating a transmission line within the study area. The report concludes by identifying a set of corridor segments that represents the least constraining corridor for transmission line development.

There is a potential for the electrical utility to share a common corridor with a proposed natural gas pipeline and a new road servicing the LNG site. This type of shared right-of-way for linear developments has been used in other parts of North America, and has proven to be less impacting than the use of separate rights-of-way. Adverse effects are generally lower because the net amount of land affected by development is less.

This environmental report examines two conditions: one which analyzes the impacts of the transmission line only, and one which considers common corridor impacts.

Each of the ten corridor segments* analyzed in this study is summarized below, noting the potential significant impacts and severe environmental constraints. The segments are presented from south to north. (See Figure 2-1).

Kloiya Bay (A-B) - No significant impacts are expected within this corridor segment, as long as a prominent 100 m knoll at the mouth of Kloiya Bay is avoided. A cleared right-of-way on the exposed slopes or a transmission structure on top of the knoll would result in significant adverse visual impacts.

Morse Basin West (A-C) - Most of the potentially significant impacts within this segment can be avoided through careful route selection. A number of small bogs cover a large portion of Kaien Island, including a large bog/bog woodland complex north of Hospital Cove. The east slope of Mt. Oldfield and the north slope of Mt. Stewart are subject to occasional debris slides. City planners should be consulted to coordinate a route through a proposed residential area southwest of Butze Rapids.

The most severe impact would occur at Seal Cove, where current seaplane operations provide transportation services for North Coast communities. Location of an overhead transmission line across Fern Pass would require the relocation of this air base, due to the hazards presented to aircraft. Assuming a suitable alternate waterfront location could be found, relocation would be costly and disruptive.

Crossing Fern Passage with an overhead transmission line would also adversely impact the visual quality of the waterfront landscape. Tentative plans by the City of Prince Rupert call for a pedestrian walk along the waterfront between Hays Creek and Seal Cove. A more southerly crossing would mitigate potential visual impacts.

* one corridor was dropped from further analysis early in the study process due to severe environmental concerns.

Use of a common corridor in the Morse Basin West segment would combine the transmission line right-of-way with a new road. A bridge crossing at Fern Passage may endanger current seaplane operations, and would require relocation of the airlines and aircraft maintenance firms at Seal Cove. A low bridge would also limit boat traffic through Fern Passage. An arched, draw, or swing bridge would still present additional navigation hazards in already dangerous waters. A bridge would probably not open up new land for residential development because of the watershed restrictions and soil constraints on the mainland side of Morse Basin. If a bridge and road were constructed in this segment, a transmission line within the same corridor would add no significant impacts.

Morse Basin East (B-C) - Potential visual impacts are the only environmental concerns within this segment. A transmission line and clear zone on the exposed slopes near the "elbow" of Morse Basin would be visible from the Galloway Rapids Bridge, the shoreline at Hospital Cove, proposed residential units south of Butze Rapids, and from boats in Morse Basin. Possible future development on the western shore of Morse Basin would enhance the value of the pristine shore opposite. Visual quality within the southern half of the Morse Basin East segment is high. However, distances to viewing stations exceed 1.5 km, and views in this area are often obscured by fog, rain, or mill smoke.

Denise Inlet - Woodworth Lake (B-D) - No significant impacts are expected within this corridor segment if certain sensitive areas are avoided. Construction crews should not use the tidal marsh at the head of Denise Inlet for barge and equipment landings because of the sensitivity of this habitat. Careful construction methods should be used to avoid the highly sensitive bog/bog woodland vegetation in the vicinity of Mahlon and Bannock Lakes. Construction activities could also result in the addition of sediment to Woodworth Lake, the main source of the Prince Rupert water supply.

The common corridor concept in the Denise Inlet-Woodworth Lake segment would team the transmission line with a proposed high-pressure natural gas pipeline. The main concern is for watershed impacts and adverse effects to sensitive vegetation between Denise Creek and the Shawatlan River. A common right-of-way would be beneficial in this region, and common access roads should be used. If it is found necessary to build structures along another route in the Woodworth Lake watershed, helicopter construction should be considered in steep terrain to avoid the impacts of additional spur access roads.

Shawatlan Lake (C-D) - No significant impacts are expected if the transmission line avoids the shoreline and marsh nesting cover of Shawatlan Lake. Significant visual impacts can be avoided by running the line eastward of the exposed slopes leading to Prince Rupert Harbour.

A road and transmission line within this corridor would cause no significant adverse effects since the majority of the corridor is outside the watershed area and the crossing of the Shawatlan River is below the water intake.

Laurier Cove (D-E-F) - Laurier Cove presents a number of environmental constraints to transmission line development. Steep mountain sides on both sides of the cove present risks of slope instability. A sensitive tidal marsh could be avoided by the transmission line, although Silver Creek could be endangered by siltation and sediment flows associated with construction. Spawning habitat in Silver Creek could be reduced. Moderate visual impacts are likely because of exposure of Laurier Cove to boaters and the community of Prince Rupert (12 km south).

A common corridor within the Laurier Cove segment would combine the road, pipeline and transmission line in one right-of-way. No alternative to this segment exists. Severe problems would be faced at Laurier Cove, where geotechnical difficulties and limited space would not easily accommodate the three utilities. A bridged road crossing of Silver Creek would be required. Due to the instability of the steep slopes,

construction work could cause serious siltation and slumping and adversely impact spawning habitat. A heritage site at Laurier Cove would require coordination of any route selection and construction work with the Heritage Conservation Branch. In addition, the combination of road, pipeline, and transmission line would be highly visible.

Tuck Inlet West (F-G west) - Geotechnical constraints present construction difficulties in this segment, where a high concentration of debris slides and torrents exist. Steep slopes along the northern half of this segment are subject to debris slides which would be difficult to avoid. In addition, valuable forest resources extend from Tuck Point northward to the head of the inlet; this forest area presents a severe constraint to transmission line development within the segment. Crossing Tuck Narrows from Laurier Cove with an overhead line will result in moderate to high visual impacts. Visual impacts could be severe if tall, red and white structures are used to provide an aircraft warning. One heritage site at Tuck Point may be adversely affected by structure placement and construction.

Tuck Inlet East (F-G east) - No significant impacts are expected within this segment if sensitive bog vegetation areas are avoided.

A common corridor containing a road, pipeline and transmission line would be difficult to establish due to the limited space available within the entire segment. Further engineering studies would be necessary to determine the feasibility of three linear facilities in this segment. The use of Tuck Inlet West may be necessary to accomodate the transmission line, if crowding and potential high environmental impacts are identified.

Georgetown Lake-Port Simpson (G-I) - No significant impacts are expected within this segment if certain sensitive habitats are avoided. Damage to Stumaun Creek and Lahon Creek could be minimized by constructing transmission line access routes well away from these channels. Where stream crossings are necessary, bridges rather than culverts should be installed. Construction activity near Neaxtoalk Lake must be carefully planned to preserve the valuable wildlife, recreation, and visual

resources of the lake. The transmission line right-of-way should pass to the northeast and avoid the outlet of Neaxtoalk Lake. Dome Petroleum Limited is presently negotiating with the Port Simpson Indian Band for use of the Georgetown Lake-Port Simpson segment which crosses their Reserve.

A common utility corridor extending from Tuck Inlet to the LNG Terminal at Grassy Point could result in significant impacts to Georgetown Lake, Lahon Creek, Stumaun Creek, Stumaun Bay, and Neaxtoalk Lake. Damage could be minimized by avoiding sensitive areas, reducing the introduction of sediment and debris into the water courses, and implementing mitigation measures during construction. If a road and gas pipeline were constructed within this segment, a transmission line within a common corridor would add insignificant impacts.

Work Channel (G-H-I) - Geotechnical constraints are a factor in routing a transmission line through this corridor segment. Steep slopes and sensitive bogs present difficult engineering problems at the pass between Little Georgetown Creek and Work Channel. The southern part of this segment includes some of the highest quality forest resources in the study area. Some forest production would be lost with any route alignment through this segment. A transmission line running through the pass may also be visible against the sky to a small extent. High altitude (700+ ft, 200+ m) clearing cuts for the right-of-way would be visible for 10 km or more to boaters using Work Channel, disrupting the untouched scenic quality of Work Channel.

In concluding the evaluation, the report presents an environmental constraint map produced by overlaying areas of severe and very severe sensitivities. The evaluation focussed on the corridor segments with the least number of environmental constraints.

Three decisions are necessary for selecting a corridor. The first choice is along the Morse Basin West, Morse Basin East, and Denise Inlet-Woodworth Lake segments. The three segments are similar in terms of overall constraints. However, the changes expected in the environment from a proposed bridge crossing of Fern Passage and a proposed gas pipeline influence the selection of preferred corridors. The Morse Basin West segment would be preferred if the proposed bridge were to cross Fern Passage. If the road were located elsewhere and the pipeline were constructed where proposed, the Denise Inlet-Woodworth Lake segment would be preferred.

The Shawatlan Lake segment shows few constraints, and the Laurier Cove segment is unavoidable. Impacts are expected to be high at Laurier Cove; careful route planning and detailed mitigation measures are necessary in this area.

The second choice in selecting a corridor involves the Tuck Inlet West and Tuck Inlet East segments. An overhead crossing to Tuck Point would have high visual impact, and a high slide potential is noted for Tuck Inlet West. If slides and/or erosion should occur, increased environmental impacts are likely. Therefore, Tuck Inlet East is designated as the preferred choice, regardless of common corridor impacts.

The final decision involves a choice between the Georgetown Lake-Port Simpson and Work Channel segments. The Work Channel segment has a concentration of impacts in the area of Georgetown Creek, including effects on highly productive forest sites. A transmission line at the pass between Georgetown Creek and Work Channel would also be highly visible from Work Channel. The Georgetown Lake-Port Simpson segment shows few environmental constraints, which are localized and avoidable. Therefore, the Georgetown Lake-Port Simpson corridor segment is the preferred choice.

1.0 INTRODUCTION

In September, 1982, TERA Environmental Consultants Ltd. was contracted by B.C. Hydro and Dome Petroleum Limited to conduct environmental studies for a proposed 230 or 287 kV transmission line from the Prince Rupert substation to Grassy Point northeast of Port Simpson. This line would service Dome Petroleum Limited's Western Liquefied Natural Gas (LNG) project at Grassy Point. The Western LNG project involves a liquefaction plant and export terminal at Grassy Point near Port Simpson, B.C., 30 km north of Prince Rupert, serviced by an access road, pipeline, and high-voltage transmission line from the vicinity of Prince Rupert. B.C. Hydro has identified feasible route options for the transmission line which are each about 48 km in length. The location of the general study area is shown in Figure 1-1.

The study approach is contained in our proposal dated August, 1982, to B.C. Hydro and Dome Petroleum Limited and further detailed in Section 2.0 of this report.

1.1 Study Objectives

The overall objective of this study is to review, on an environmental basis, the feasible transmission line corridors identified by B.C. Hydro and recommend corridor alternatives.

Mitigation measures are outlined for all corridors. Environmental constraint mapping is used to identify the least environmentally sensitive route within the study corridors. In addition, planned and possible future developments in the corridors are considered, with regard to their biophysical and socio-economic interaction with the proposed transmission. In particular, the planned access road and pipeline will affect the degree of environmental impact in some areas of the corridors where these facilities are adjacent to the transmission line. This concept of a "common corridor" (Hayward, 1982), is examined to note the differences in impact with and without multiple facilities.

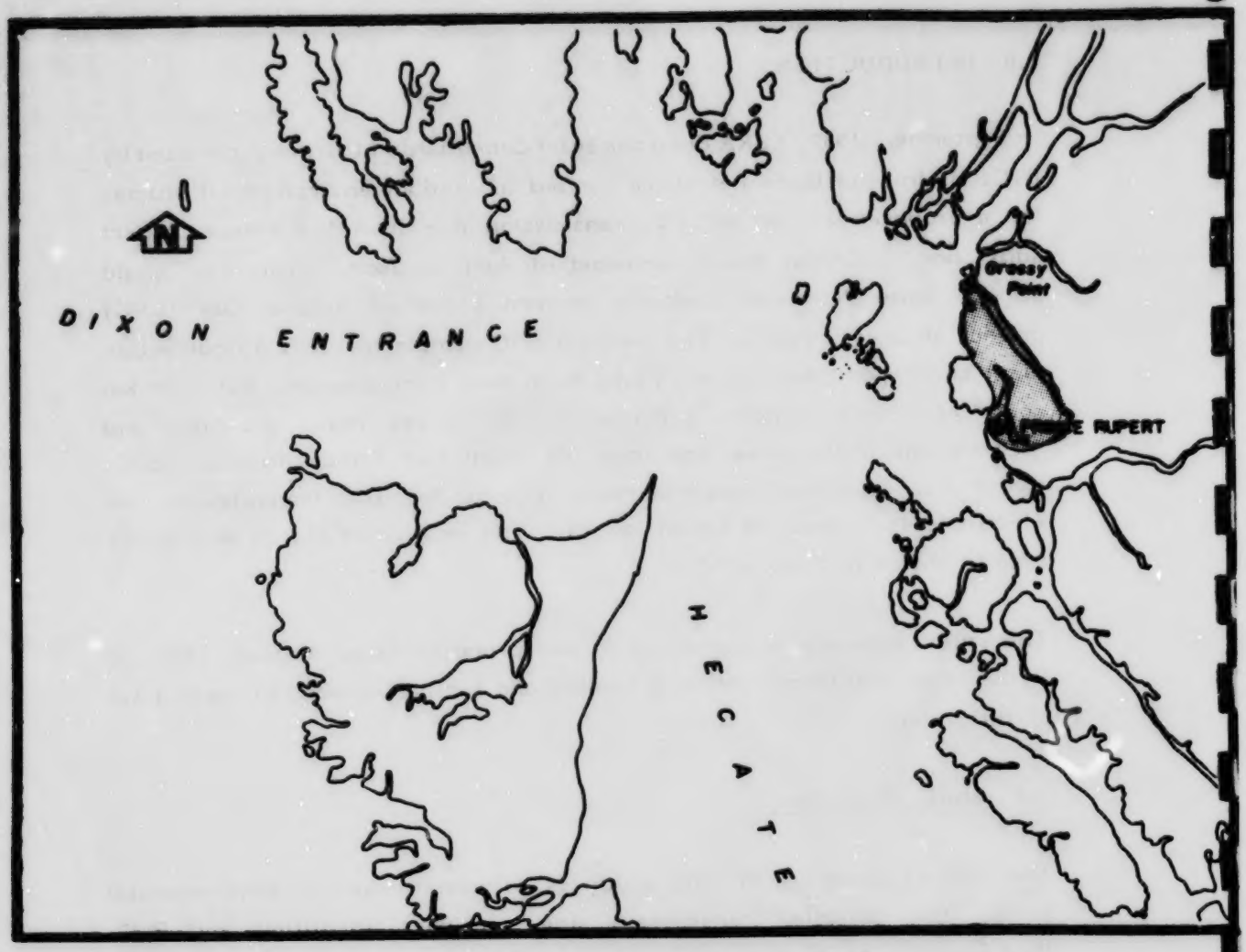

FIGURE 1-1: STUDY AREA

1.2 The Study Area

The study area encompasses the Tsimpsean Peninsula as far north as Grassy Point. (Figure 1-1). The Tsimpsean Peninsula is part of the Coastal Trough of British Columbia (Holland, 1967) which extends the length of British Columbia. In particular, the Tsimpsean Peninsula belongs to the Hecate Depression, between the Queen Charlotte Islands and the mainland. For the most part, the study corridors are confined to the area between Tuck Inlet and Work Channel. The southern boundary of the study area is formed by the southern shore of Morse Basin and Denise Inlet.

1.3 The Study Team

Project Manager	Stephan J. Houseknecht
Coordination and Editing	Janet Waterman
Graphics	Janet Lee Barbara Gibson
Climate, Terrain, Water Resources and Mining	Peter Jordan Janet Waterman
Vegetation and Forestry	Stephan Houseknecht Paul Jones, R.P.F.
Agriculture	Michael Goldstein, P.Ag.
Wildlife	Ian Sharpe
Fish	Ian Sharpe
Settlement	James LaMorte
Recreation	Ian Sharpe
Visual Analysis	James LaMorte
Heritage Resources	ARESCO Ltd.

1.4 Report Organization

The report follows a standard environmental impact statement format, including separate inventory, assessment and evaluation sections.

Section 3.0 provides an environmental description of the thirteen (13) physical and biological resources found in the study area. These descriptions provide data for assessing the sensitivity of the various biological and physical components of the study corridors.

Section 4.0 discusses general mitigation measures.

Section 5.0 applies the environmental assessment to determine the impacts the proposed transmission line may have on the various biological and physical components. Specific mitigation measures are then described which would alleviate or lessen potential environmental impacts on a corridor segment basis.

Section 6.0 discusses the corridor that has the least environmental impacts. An environmental constraint map is provided that identifies areas of impact based on an overlay approach.

2.0 CORRIDOR EVALUATION PROCESS

B.C. Hydro provided twelve major route options to connect the Prince Rupert substation to the substation to be located at Grassy Point. Within these route options eleven segments exist. The consultants reviewed this information and determined corridors approximately 2 km in width for further study. These are shown on Figure 2-1.

The Silver Creek option (Figure 2-1) was subsequently dropped from further analysis because an initial review of the corridor indicated it had severe constraints with regard to fisheries, wildlife habitat and slope stability. From an engineering point of view, it also was costly.

B.C. Hydro agreed that a feasible route could be found within the remaining corridors, while the consultants felt a 2 km corridor width was sufficient to evaluate the environmental attributes.

The consultants identified constraints on transmission line development within the corridors and assessed the potential impacts of transmission line construction and operation within each corridor. Many of the impacts could be overcome by careful route selection within a corridor. When evaluating the potential impacts, the transmission line was assumed to be a 287 kV single circuit with wood pole construction. The right-of-way width was assumed to be 31.6 m. It was also assumed that standard mitigation procedures used on 287 kV lines would be adhered to. Discussions were held with B.C. Hydro construction personnel to brief the consultants on the process involved in building a transmission line in a northcoast environment. Mitigation measures were developed for each corridor segment based on the potential impacts and standard B.C. Hydro construction practice.

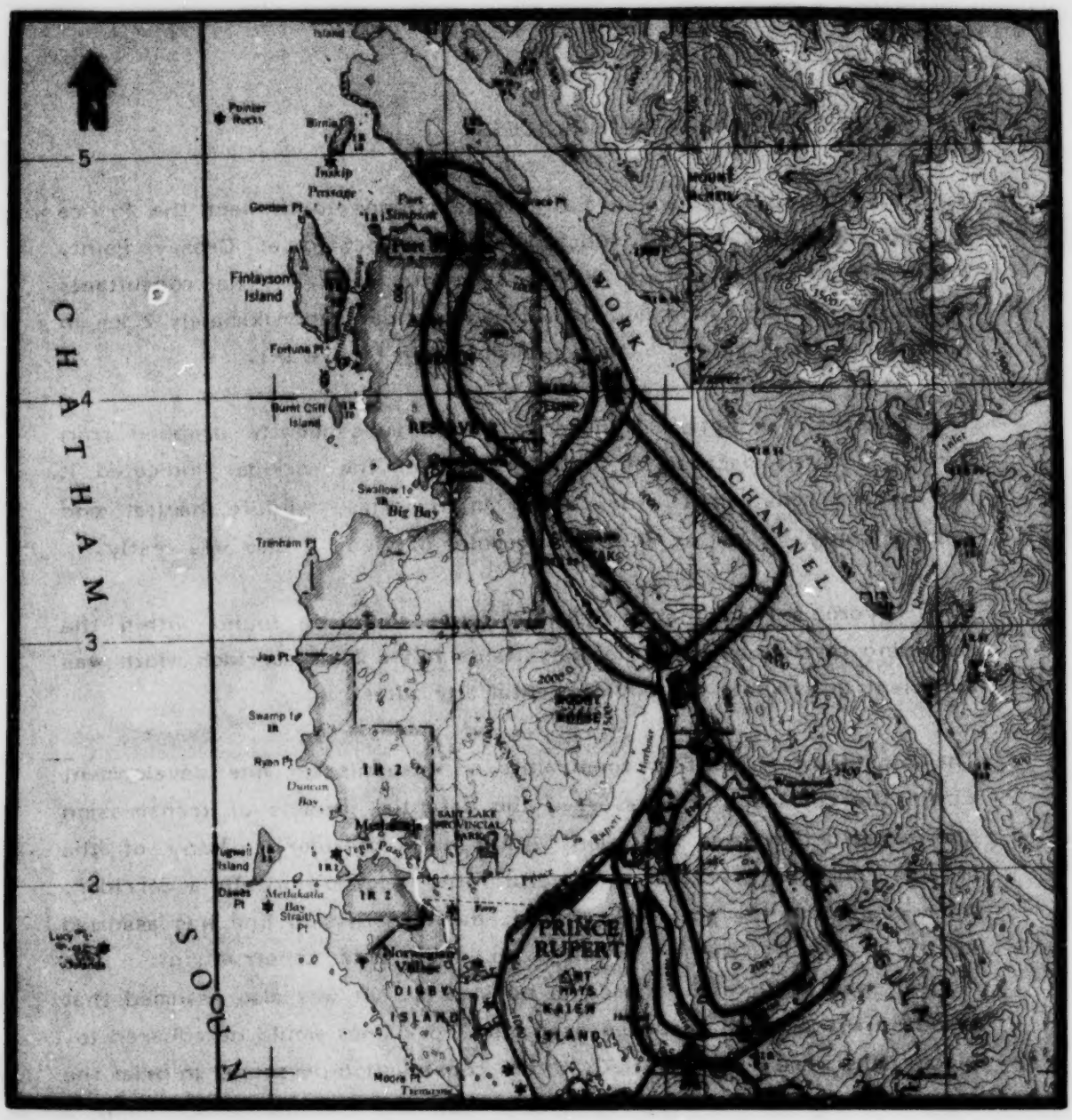

FIGURE 2-1: CORRIDOR OPTIONS

Routing	Name
A-B	Kloiya Bay
A-C	Morse Basin West
B-C	Morse Basin East
B-D	Denise Inlet-Woodworth Lake
C-D	Shawatlan Lake
D-E-F	Laurier Cove
E-H	Silver Creek*
F-G (east)	Tuck Inlet East
F-G (west)	Tuck Inlet West
G-H-I	Work Channel
G-I	Georgetown Lake-Port Simpson

* no longer under consideration

Scale: 1:250,000

Following the identification of potential impacts, the environmental constraints for all disciplines that were rated as high (see Section 3.0 for definition) were mapped in an overlay technique to determine areas of multiple impacts. The overlay method was chosen since it best identifies areas of environmental concern as well as areas within the corridors where the location of a transmission line would have the least impacts on the environmental resources. The corridor with the least environmental constraints was identified by the consultants in committee considering factors such as the severity of the constraints, their extent and ease of avoidance, and perceived importance (Section 6.0).

Early discussion with Dome Petroleum Limited indicated that they had established a committee to address native issues for all developments in the Port Simpson area. In addition, a socio-economic study (Read, 1982) was already underway that would address native utilization of the fish and wildlife resources. Consequently, Dome Petroleum Limited instructed TERA Environmental Consultants Ltd. to rely on this study for the evaluation of impacts to native peoples on the Tsimpsean Peninsula. Reference to this document is made in the appropriate sections of this report.

2.1 Common Corridor Concept

There is a need for three linear facilities to service the Western LNG project, namely, a pipeline, a transmission line and a road. Dome Petroleum Limited's access road to the Western LNG Project site would have controlled access and be gravel surfaced to an approximately 50 km/hr. standard. The proposed location of the road and pipeline are shown on Figure 2-2, while the location of the transmission line is the subject of this study (Figure 2-1). It is evident after reviewing Figures 2-1 and 2-2 that these three facilities follow a common corridor in a number of locations, most notably, along the east side of Tuck Inlet.

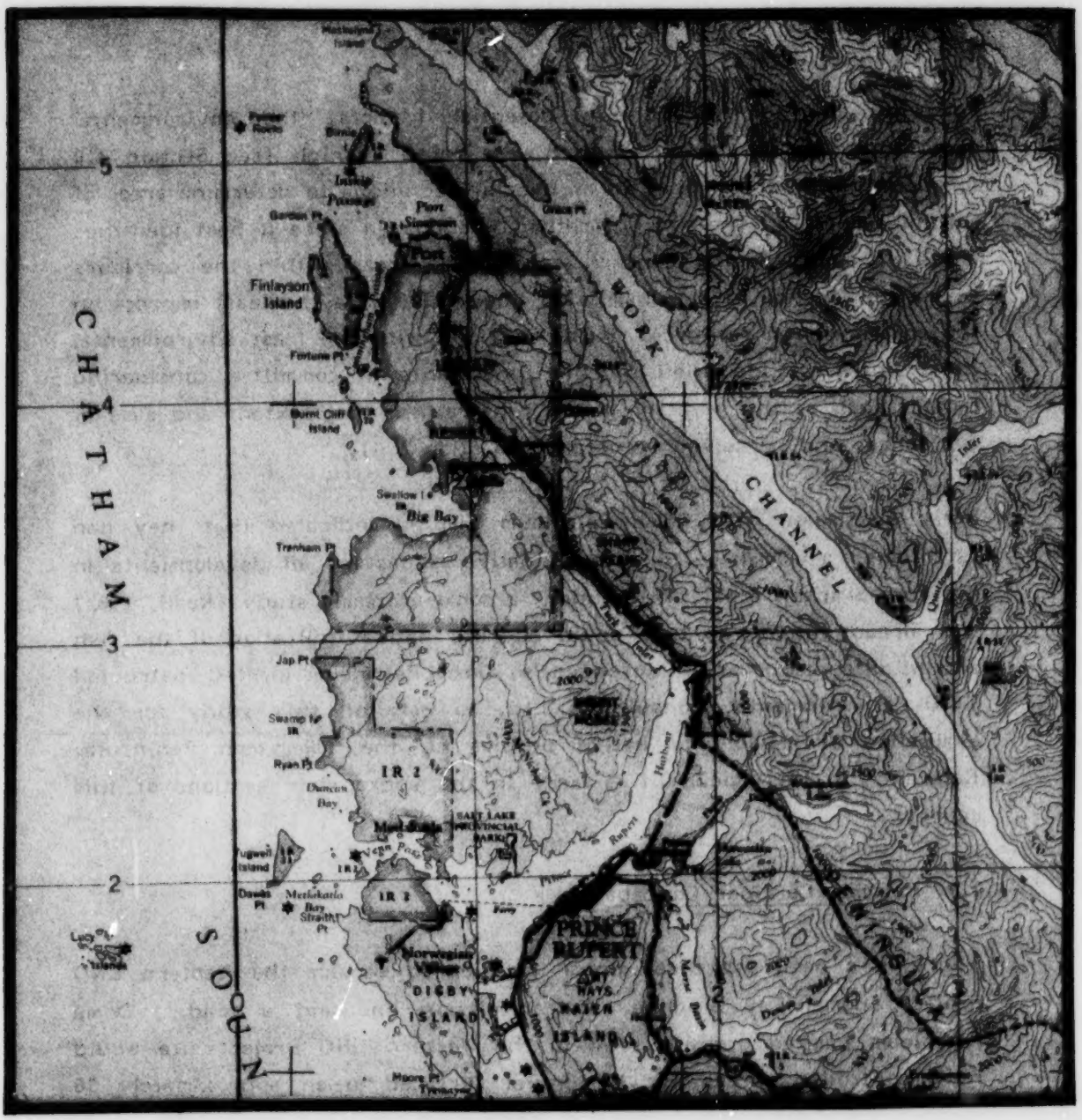

FIGURE 2-2: PROPOSED FACILITIES

——— road ------- pipeline

Scale: 1:250,000

The common corridor concept has frequently been applied in other parts of North America especially near suburban areas. A common corridor is defined as a narrow strip of land containing either a shared right-of-way or easement, common right-of-way or easement, or adjacent right-of-way or easements" (Hayward, 1982). In B.C., the use of common corridors is infrequent, but the Ministry of Energy, Mines and Petroleum Resources is interested in encouraging the planned development of rights-of-way in B.C. To this end, the Western LNG Project Facilities Coordinating Committee was set up by the consortium of users involved in the Western LNG project. Common corridors must be planned and managed. Therefore, plans must be established at project inception to develop and coordinate the common corridor concept.

The environmental impacts associated with the common corridors are generally thought to be lessened by reducing the amount of land affected by development and optimizing the use of this land through proper planning and management. Any environmental impact statement should consider impacts both as a result of a single linear facility and multiple facilities (common corridor).

The route alignments for the linear facilities to Grassy Point, are preliminary and subject to change. Therefore, this environmental report on the impacts of the proposed transmission line has evaluated two cases, one which analyzes the impacts of the transmission line only, and one which considers common corridor impacts. Road and pipeline alignments shown in Figure 2-2 were used to assess common corridor impacts with the transmission line where common alignments occurred (Section 5.0). It was not within the context of this study to evaluate the impacts as a result of multiple linear facilities, but common sense environmental planning requires that they be considered.

3.0 ENVIRONMENTAL DESCRIPTION

3.1 CLIMATE

3.1.1 Methods

Climate data for the study area, presented and summarized in NEAT (1975) and Dome (1981) were reviewed. These data are based on Atmospheric Environment Service stations in and around Prince Rupert. A limited amount of additional data from Port Simpson is available.

Areas which may present special climatic problems for transmission lines, such as exposure to winds or icing, were noted from examination of topographic maps. No information is available on wind or precipitation at high elevations or inland locations, where it would be relevant to the proposed transmission project. Wind and other data are available for a number of offshore locations, and are presented in the above references.

3.1.2 Inventory

As climate information is presented in detail in the above-mentioned references, only a very brief review is given here. A summary of climate data is given in Table 3-1. The "Prince Rupert" station is located at the marine station on Digby Island. Precipitation is measured at four other stations. Those on Kaien Island record slightly higher precipitation; "Prince Rupert Mont Circ" at 85 m on Kaien Island has recorded a mean annual precipitation of 3147 mm, and a maximum 24-hour rainfall of 175 mm, based on 22 years of record.

The precipitation of the study area is high and is mostly in the form of rain. Fall and early winter are the wettest periods of the year with the highest monthly precipitation occurring in October. Annual temperature range is moderated by the oceanic influence. No month experiences mean temperatures below freezing.

Precipitation can be expected to increase with elevation. No published information is available on precipitation or snow accumulations at higher

elevations, although considerable depths of snow might be expected to persist at elevations above about 500 m. Snow avalanche tracks are not widespread in mountains on the Tsimpsean Peninsula of elevations below about 800 m. The prevailing wind direction in the Prince Rupert area is from the southeast, and the highest speed winds occur from this direction. The highest wind speeds occur in the months of October to April.

3.1.3 Assessment

Construction and operation of a transmission line has no impact upon the atmospheric environment, apart from very localized effects on wind in the vicinity of a cleared right-of-way. However, exposure to high wind speeds, ice accumulation, and snow depths is of engineering concern.

The pass between Little Georgetown Lake and Work Channel, which lies at an elevation of about 410 m and is above the local timberline, may be very exposed to high winds and ice accumulation. Heavy snowfalls and snowpack accumulations might also be expected at this location. South-east winds are likely to be funnelled by Work Channel, and are unimpeded by any obstruction for at least 30 km upwind. Outflow winds from the interior in winter also could conceivably be directed at this pass by the Ensheshese River valley which is located directly across Work Channel. Exposure to wind is high throughout the length of this corridor along Work Channel. No unusual exposure to wind is expected along any other corridors.

Inclement weather conditions typical of the north coast in fall and winter can affect construction activities. During the period of highest precipitation and soil moisture levels, from October through February, soil erosion and slope failures resulting from construction are likely to be more prevalent than would be expected during the summer. Flood flows in creeks and rivers, and the possibility of debris slides and torrents, can also affect construction activities in the fall and winter, as can poor visibility resulting from rain and low cloud. Poor visibility, road washouts, etc. can also make maintenance visits difficult in the fall and winter.

Table 3-1 Summary of Climate Statistics for Prince Rupert-Port Simpson Area[a]

	Prince Rupert[b]	Port Simpson[e]
Elevation	52m	8m
Period of record	1951-1980	1886-1907
Mean annual temperature	7.4°C	6.9°C
Extreme maximum temperature	32.2°C	
Extreme minimum temperature	-21.1°C	
Mean annual precipitation	2403.1mm	2340mm
Mean annual snowfall	84.1cm	
Maximum recorded daily rainfall	141.0mm	
Maximum recorded daily snowfall	38.1cm	
Maximum mean monthly precipitation	October, 352.5 mm	
Calculated extreme 24 hr rainfall intensity, 25 year return period[c]	6.4mm/hr	
Maximum recorded hourly wind speed	93 km/hr (S.E.)	
Calculated extreme hourly wind speed, 30 year return period[d]	80 km/hr	

Notes:

a) Atmospheric Environment Service data summarized in NEAT (1975) and Dome (1981).

b) "Prince Rupert" climate station is located on the east shore of Digby Island. Mean climate data are reduced to the standard 30-year period of 1951-1980, but are based on an actual period of record of 54 years. Wind data are from Prince Rupert Airport with 18 years record.

c) Atmospheric Environment Service calculation reported in Dome (1981).

d) Calculated by ESL in Dome (1981).

e) Port Simpson data are not adjusted to standard period.

PRINCE RUPERT 54° 17'N 130° 23'W 52 m	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE
Daily Maximum Temperature	4.3	5.6	7.0	9.7	12.7	14.7	16.5	16.7	15.0	11.4	7.5	4.9	10.5
Daily Minimum Temperature	-1.0	0.1	0.6	2.4	5.0	7.9	10.1	10.3	8.3	5.7	2.5	0.3	4.4
Daily Temperature	1.7	2.9	3.8	6.1	8.9	11.3	13.3	13.5	11.7	8.5	5.0	2.6	7.4
Standard Deviation, Daily Temperature	2.4	1.5	1.4	1.1	1.0	1.2	0.8	0.8	0.8	1.2	1.8	1.9	0.7
Extreme Maximum Temperature	17.8	18.9	20.0	23.3	29.4	32.2	30.6	30.0	27.2	21.7	20.0	17.2	32.2
Years of Record	53	54	53	53	53	53	53	54	55	55	53	54	
Extreme Minimum Temperature	-21.1	-17.2	-15.0	-6.7	-1.1	1.7	0.6	3.9	-1.1	-5.6	-11.7	-15.0	-21.1
Years of Record	52	53	53	53	53	53	54	54	53	55	55	54	
Rainfall	184.8	217.2	168.9	175.0	130.5	110.4	112.9	143.7	231.2	352.4	276.8	241.1	2334.9
Snowfall	23.3	15.8	16.2	5.1	0.1	0.0	0.0	0.0	0.0	0.2	3.8	19.6	84.1
Total Precipitation	218.1	218.8	185.4	180.8	130.8	110.4	112.9	143.7	231.2	352.5	281.3	266.6	2403.1
Standard Deviation, Total Precipitation	107.8	82.9	100.9	59.8	44.8	42.9	42.1	67.4	60.5	113.7	77.5	129.3	245.4
Greatest Rainfall in 24 hours	125.0	78.0	103.6	71.1	66.5	48.0	67.1	70.6	94.7	141.0	137.9	125.5	141.0
Years of Record	52	54	53	53	53	53	54	54	55	55	55	55	
Greatest Snowfall in 24 hours	38.1	27.9	28.4	22.9	1.3	0.0	0.0	0.0	0.0	5.1	16.5	27.9	38.1
Years of Record	52	54	53	53	53	53	54	54	55	55	55	55	
Greatest Precipitation in 24 hours	125.0	78.0	103.6	71.1	66.5	48.0	67.1	70.6	94.7	141.0	137.9	125.5	141.0
Years of Record	52	54	53	53	53	53	54	54	55	55	55	55	
Days with Rain	18	19	20	18	17	16	16	16	16	24	22	21	223
Days with Snow	6	3	3	1	0	0	0	0	0	0	1	4	18
Days with Precipitation	20	19	21	18	17	16	16	16	16	24	22	22	229

3.2 TERRAIN

3.2.1 Methods

The terrain inventory is based on air photo interpretation with field checking. Previous work was used to provide an overview of the surficial geology and geomorphology of the study area, and for an initial identification of terrain units.

A description of the surficial geology of the Tsimpsean Peninsula, and of mass movement and terrain sensitivity, is given in NEAT (1975); this source also includes a small-scale (1:200,000) map of terrain sensitivity. Further information for parts of the study area is found in Hinton and Assoc. (1975) and DOME (1981, 1982). A review of terrain hazards in the Prince Rupert-Skeena area is given by Clague (1978). Bedrock geology has been mapped by the Geological Survey of Canada (Hutchison, 1982), and unpublished surficial geology maps for the southern part of the area are also available (Clague, pers. comm.). Terrain maps and development suitability maps at a scale of 1:50,000 are available for the entire study area (B.C., Terrestrial Studies Branch, undated; Baender and Kenk, 1981); however, these maps are believed to be of low reliability for much of the study area.

Air photos at a scale of about 1:20,000 (1977) were used for initial terrain unit identification. Field checking was done by helicopter for all corridors except Morse Basin West, which is accessible by road. Ground inspections were made at a number of sites which are shown on Map 1. Forms describing the surficial geology and soils were completed at each site; a sample form is included in Appendix B. Particle size analyses for four samples are given in Appendix C.

The terrain classification system used by the B.C. Terrestrial Studies Branch (B.C., E.L.U.C. Secretariat, 1976; Ryder, 1981) was used for mapping, with minor modifications. The classification legend is given in Appendix D. Because the terrain units in this particular study area are complex, and many map units are small, numbers rather than classification

symbols are used. The classification for each unit is given in the legend for Map 1.

Terrain units were assessed as being of low, moderate, or high sensitivity. These ratings apply in general to any development which involves clearing of vegetation and building of roads, and in particular to transmission line construction. The assessment is based on the following criteria:

High Sensitivity: Severe soil erosion or disruption of drainage would be expected if construction were to take place. Mitigation of impacts would be difficult. Helicopter construction may be the only suitable mitigation measure. This rating was applied to deep organic deposits (muskeg), deltas, and estuaries.

Moderate Sensitivity: Some soil erosion and disruption of drainage would be expected; however, most adverse impacts can be mitigated with appropriate construction procedures. This rating was applied to terrain units with shallow or discontinuous muskeg, and to areas with slopes of over 30% or with evidence of past mass movement or soil erosion.

Low Sensitivity: No adverse terrain impacts would be expected with normal construction procedures.

Areas of "high" and "moderate" sensitivity are shown on Map 1. Areas not so marked are of "low" sensitivity.

In addition to terrain sensitivity, terrain units which present geotechnical limitations to transmission line construction and operation are mapped. These units are primarily steep slopes and associated colluvial deposits which show evidence of debris slides.

It was assumed that a single transmission line on wood poles would be built, together with an all-weather access road for construction and maintenance. In some segments, the corridor would also be occupied by the pipeline and highway. Although the overall evaluation of a corridor

is affected by the number and location of other facilities located in the corridor, the sensitivity of a terrain unit is not affected; common use of the corridor was therefore not considered in producing the terrain sensitivity map.

The main limitation affecting terrain mapping is the difficulty of field checking. Dense forest or muskeg covers most surficial deposits, and organic soils form an impenetrable mat of roots and wood debris over most of the study area, which makes digging to mineral soil extremely difficult. Natural exposures are limited to roads in the Prince Rupert area and at logging sites, and the occasional landslide. Much of the interpretation of surficial material was made from the type of vegetation cover.

3.2.2. Inventory

a) Physiography and Bedrock Geology

The study area is included in two physiographic regions, a coastal lowland which is part of the Hecate Depression, and an upland forming the central spine of the Tsimpsean Peninsula which is part of the Kitimat Ranges of the Coast Mountains (Holland, 1964). Most of the corridors examined lie within the central upland; the Georgetown Lake-Port Simpson Corridor and the Grassy Point terminal area are in the coastal lowland. The Shawatlan Lake and Morse Basin East and West corridors lie in a broad valley bordering Prince Rupert Harbour which is topographically similar to the lowland region.

Most of the coastal lowland lies at an elevation of about 100 m or below, with occasional hills reaching above 500 m. Large areas to the west of the study area are nearly flat, with poorly-organized drainage and extensive areas of muskeg. The central uplands are rugged, with deep, steep-sided valleys and peaks reaching 1000 m in elevation. Although there are no glaciers at present, evidence of intense alpine glaciation is abundant. Within the upland, some major valleys, such as the one occupied by Morse Basin and Prince Rupert Harbour, are flanked by narrow strips of lowland.

The study area shows a pronounced northwest-southeast alignment of physiographic features, related to the structural geology of the western edge of the Coast Plutonic Complex (DOME 1981, 1982). Especially prominent is the long straight fjord of Work Channel which follows a fault system separating the central upland from the higher mass of the Kitimat Ranges. A number of less distinct parallel features are apparent, such as the lineament which follows a rough line from Georgetown Lake to Prudhomme Lake. A second set of parallel features, also related to geologic structure, lies approximately at right angles to the main lineation, and forms a set of narrow valleys cutting across the main ridges. These are occupied by such features as Little Georgetown Lake, Silver Creek, Denise Inlet, and Prudhomme Lake.

Most of the Tsimpsean Peninsula is underlain by metamorphic rocks, which increase in grade of metamorphism from west to east. The geology of these rocks strongly influences the topography, soils, and slope stability of the study area. The main geologic units are shown in Figure 3-1; the unit numbers below refer to this figure. The following descriptions are summarized from Hutchison (1982).

The coastal lowland on the western margin of the study area is occupied by metasedimentary rocks of greenschist facies (4) (micaceous schist, phyllite, and greywacke) and weakly metamorphosed volcanic rocks (3).

Higher-grade metasedimentary rocks of amphibolite facies (2) form a double arcuate belt centred on Georgetown Lake, Tuck Inlet, and Prince Rupert Harbour. This unit is composed mainly of hornblende-biotite-garnet schist, graphite schist, and minor quartzite and gneiss. Layering in the unit is pronounced, and has produced a ridged microtopography resulting from differential glacial erosion. Layering and schistosity generally run parallel to the axis of the belt, and dip steeply eastward (northeast from Port Simpson to Tuck Point; south-east at Prince Rupert). The dip of these layers may influence slope stability to some extent, depending on whether the layering coincides with, or cuts across, mountain slopes.

The central upland is underlain by a gneiss complex (1), which represents the most highly metamorphosed unit. It consists of biotite-hornblende gneiss, with minor migmatite, amphibolite, and interbedded schist. On the western side, this unit is gradational with unit 2, and shows pronounced, steeply dipping layering, with foliated micaceous gneiss and interbedded schist. Further east, especially along the ridge paralleling Work Channel, the gneiss is more thickly layered and massive, and includes migmatite. The structure of the gneiss is complex, and may be affected by intrusion of the plutonic rocks which occupy the southern part of the peninsula, from Prudhomme Lake to the Skeena River.

The age relationships of the metamorphic rocks are uncertain. Bedded rocks of the gneiss complex (unit 1) were originally Paleozoic, while

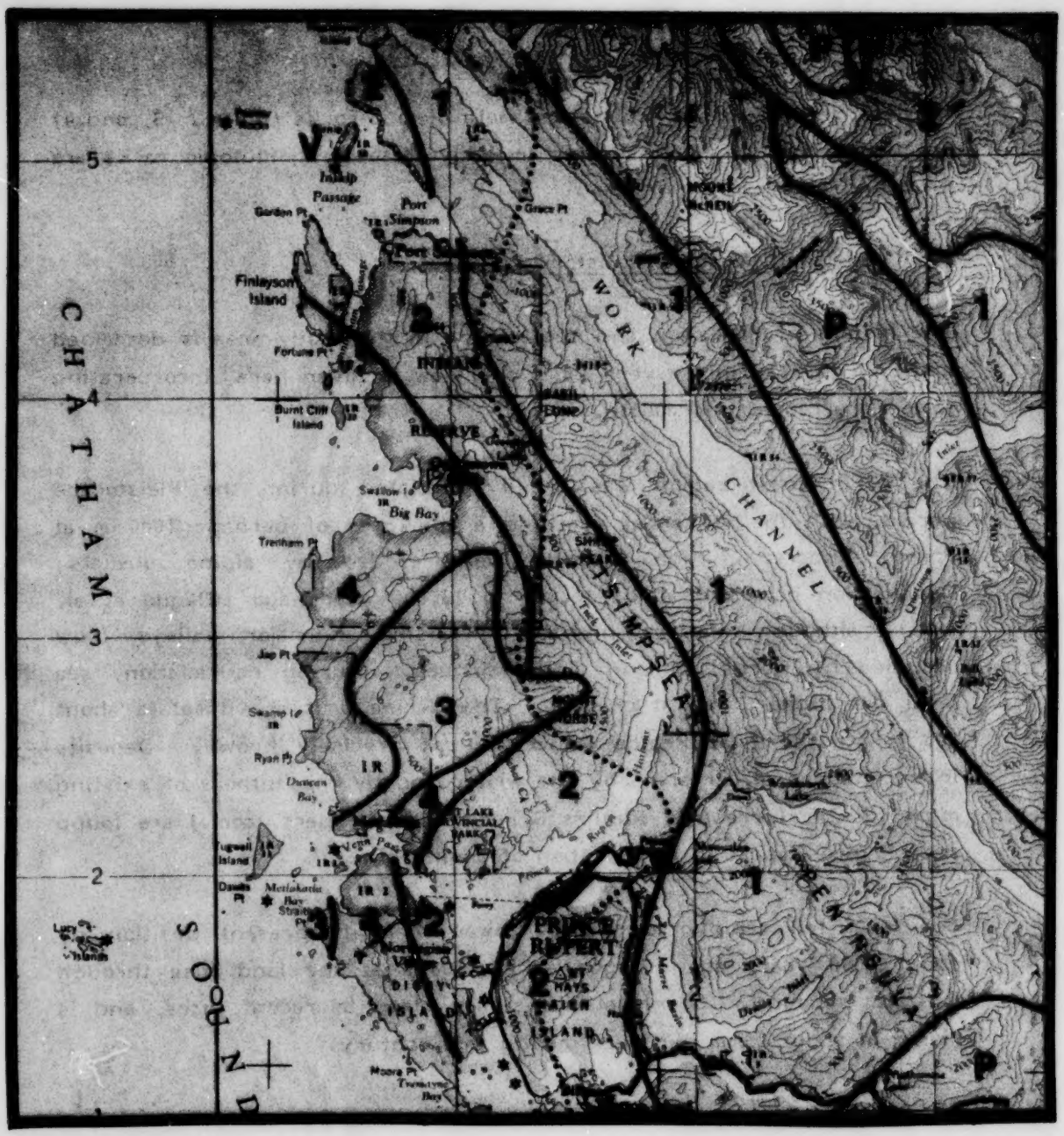

FIGURE 3-1: BEDROCK GEOLOGY AND PHYSIOGRAPHY
Source: Hutchison, 1982.

1 Central gneiss complex
2 Metasedimentary rocks - schist and gneiss
3 Weakly metamorphosed volcanic rocks
4 Metasedimentary rocks - schist and phyllite
P Plutonic rocks
V Tertiary volcanic rocks

····· Approximate eastern boundary of coastal lowlands

Scale: 1:250,000

the less metamorphosed schists and metavolcanic rocks (units 2, 3, and 4) are believed to be late Paleozoic to early Mesozoic. Plutonic rocks are probably late Mesozoic in age.

b) Glacial and Postglacial History

The history of glaciation and deglaciation in the study area is described in NEAT (1975); only a very brief overview is given here, incorporating some more recent information.

The north coast region was heavily glaciated during the Pleistocene period, with the ice sheet reaching a thickness of perhaps 1000 m at Prince Rupert. High summits were eroded by alpine glaciers. Deglaciation occurred about 11,000 to 13,000 years ago (Clague et al, 1981), although glaciers probably persisted in major valleys (now occupied by fjords) and in alpine cirques. During deglaciation, sea level was higher than at present. The marine limit at Kitimat is about 200 m; the limit at Prince Rupert is not precisely known. Deposits interpreted as glaciomarine by the writer and by the authors of existing maps (B.C., Terrestrial Studies Branch; Clague, pers. com.) are found near Prince Rupert to an elevation of about 50 m.

Sea level fell rapidly to slightly lower than its present position by about 8000 years ago (Clague et al, 1981) as the land rose through isostatic rebound. Sea level has slowly risen in recent times, and is rising at about 1 mm per year during this century.

c) Surficial Geology

Glacial deposits in most of the study area are thin or absent. This is due to the intensity of glaciation, the lack of major valleys feeding the peninsula, and perhaps to the heavy precipitation on the north coast which may have aided in removing much material during deglaciation. At low elevations, wave action during the period of falling sea level may have removed glacial deposits from local high points and steep slopes.

At elevations above about 400 m, bare rock, and rock with a thin colluvial veneer are the most common terrain types. At lower elevations, particularly in major valley bottoms, thin glacial deposits are widespread. In the coastal lowland, bare bedrock knolls are separated by extensive areas of muskeg, which overlies morainal or glaciomarine deposits found in depressions. Mapping of surficial deposits is made very difficult by the forest and organic veneer which covers most areas, and by the lack of natural exposures.

The surficial geology is included on the terrain map (Map 1). A summary of the terrain units and their properties is compiled in Table 3-2 and a general description of the units is given below.

Morainal deposits, usually in the form of a thin discontinuous veneer, are widespread at elevations below about 1500 m and on slopes less than about 40% (units 1, 2). The deposits are usually in the form of a moderately compact sandy till. The till matrix is typically of a silty sand to muddy sand texture (sandy loam, using soils textural terms). Coarse material (pebbles, cobbles, and boulders) typically comprises 20 to 40% of the till. In shallow till veneers, these consist mainly of fragments of the local bedrock; in deeper tills they may include rock from a widespread area.

In the hummocky or ridged lowland terrain common in the study area, till-veneered slopes are interspersed with bedrock ridges, and muskeg in intervening hollows (units 1a, 2a). Deeper till deposits are found in the valley between Stumaun Bay and Georgetown Lake (unit 3).

Organic soils are found in most of the area covered by thin or discontinuous morainal deposits. Podzols are more common on the deeper deposits, and in areas which are locally well-drained due to topography.

Glaciomarine deposits have been tentatively identified only on Kaien Island, where they are exposed in road cuts and construction sites in and near Prince Rupert (units 1b and 4). They consist mainly of a thin blanket or veneer (3m or less in depth) of irregularly stratified,

TABLE 3-2. TERRAIN CLASSIFICATION

Unit	Classification	Composition and Texture	Thickness	Topography and Slope (Topographic Class)	Drainage	Soil	Slope Stability	Susceptibility to Surface Erosion	Environmental Sensitivity
1	Ov / sdMvb / Rmr	O: Peat derived from wood wood and spaghnum moss. M: Predominantly sandy till.	O: 0-1m M: 0-2m	Ridged and undulating lowlands 10-30% (e,f)	Imperfect to poor	Mesisol, Fibrisol, Podzol	Stable	Low; Moderate on locally steep slopes.	Low
1a	Ov / sdMvb / $O^{s}b$	As for unit 1.	O: 0-2m+ M: 0-2m	Undulating lowlands; more subdued than 1. 5-30% (d,e,f)	Poor to very poor	Mesisol, Fibrisol	Stable	Low	Moderate
1b	Ov / sdMvb : $sW^{G}v$ / Rmr	O,M: as for unit 1. W^{G}: Stratified sandy glacio-marine veneer.	O: 0-1m M: 0-2m W^{G}: 0.2-0.5m	As for unit 1. 5-30% (d,e,f)	Moderately well to poor	Mesisol, Fibrisol Podzol	Stable	Low, Moderate on locally steep slopes	Low
2	Ov / sdMv / Rhm	As for unit 1; morainal deposits thinner.	O: 0-1m M: 0-1m	Hummocky and undulating lowlands and hillsides 15-40% (e,f,g)	Imperfect to poor	Mesisol, Fibrisol Podzol	Stable	Low; Moderate on locally steep slopes	Low
2a	Ov / sdMv / $O^{s}bv$	As for unit 1.	O: 0-2m+ M: 0-1m	Undulating benches within unit 2. 5-30% (d,e,f)	Poor to very poor	Mesisol, Fibrisol	Stable	Low; Moderate to high in blanket bogs	Moderate
3	sdMbv	Predominantly sandy till	1-5 m	Valley bottoms; somewhat dissected. 10-30% (e,f)	Moderately well to poor	Podzol, Mesisol	Stable	Low; Moderate along stream banks	Low
3a	sdMbv/sdCv-V	As for unit 3.	1-5 m	On steeper valley slopes; gullied 20-40% (f,g)	Moderately well to imperfect	Podzol	Locally unstable on steeper slopes	Moderate	Moderate
4	Ov / $sW^{G}xb$ / sdMbv	O,M: as for unit 1. W^{G}: stratified sands	O: 0-1m W^{G}: 0-3m M: 0-3m	Subdued lowlands along Morse Basin. 5-15% (d,e)	Moderately well to poor	Podzol, Mesisol	Stable	Low	Low
5	rdCv/sdMv	C: rubbly sandy mud M: sandy till	0-1m	Steep valley sides 30-60% (g)	Imperfect to poor	Fibrisol, Folisol, Podzol	Moderately unstable	Moderate	Moderate

TABLE 3-2 (Cont.) TERRAIN CLASSIFICATION

Unit	Classification	Composition and Texture	Thickness	Topography and Slope (Topographic Class)	Drainage	Soil	Slope Stability	Susceptibility to Surface Erosion	Environmental Sensitivity
5a	rdCv/sdMv-R	As for unit 5.	0-1m	As for unit 5	Imperfect to poor	Fibrisol, Podzol Folisol	Unstable	Moderate	Moderate
6	rdCav	Rubbly sandy mud	0-3m	Base of valley sides and steep slopes. 20-60% (f,g)	Imperfect to poor	Podzol, Mesisol, Fibrisol	Moderately unstable	Moderate	Moderate
6a	rdCav-R	As for unit 6.	0-3m	As for unit 6.	Imperfect to poor	Podzol, Mesisol Fibrisol	Unstable	Moderate	Moderate
7	Rhr/rCv	Rubbly colluvial veneer and bedrock	C: 0-0.5m	Upper slopes and ridges. 20-60% (f,g)	Well to poor	Folisol, Brunisol	Stable	Low	Low
7a	Rs: rCva	As for unit 7	C: 0-2m	Steep slopes and base of cliffs. 50-100% (g,h)	Well to imperfect	Folisol, Regosol	Stable to unstable	Low	Low
8	$O^{Sb}; O^{Sb}_{Rm}/O_r/M_v$	Muskeg: mesic to fibric peat	1-3m+	Depressions, lowlands, and seepage areas. 0-10% (b,c)	Very poor	Mesisol	Stable	High	High
9	sgFr; sgFlf	Stratified gravel and sand.	1-5m+	Valley bottoms. 0-10% (b,c,d)	Moderately well to poor	Regosol, Podzol Mesisol	Stable	Low	Low
9a	sgFf; rgCf	Stratified to unsorted sandy gravel and rubble	1-5m+	Fans at mouths of steep creeks. 10-30% (e,f)	Moderately well to imperfect	Regosol	Stable to moderately unstable	Low	Low
9b	$\frac{O^{r}_{v}}{gs\ Fp}$	O: mesic peat derived from sedges F: stratified delta sand and gravel	O: 0.5-2m F: 1-5m+	Deltas on lakes	Very poor	Mesisol	Stable	High	High
E		Sand, gravel and mud of delta or littoral origin	?	Estuaries and tidal flats	Very poor	—	—	Moderate	High

moderately to weakly compacted, light brown sands. Some gravel and cobbles are present, but these make up less than 10% of the material; fines (silt and clay) probably make up less than 15%. The glaciomarine deposits overlie glacial till or bedrock, at elevations of less than 50 m. At the Ridley Island construction site, west of the study area, a material which is probably a glaciomarine till was observed. Baender and Kenk (1981) and NEAT (1975) report fine-grained glaciomarine deposits in depressions beneath muskeg in coastal locations. Soils developed on sandy glaciomarine deposits are typically podzols, with organic soils in poorly drained locations. The lowland area on the east shore of Morse Basin and Prince Rupert Harbour (mapped as unit 1) may also contain glaciomarine deposits at elevations below 50 m, since it is topographically similar to the lowlands of Kaien Island.

Glaciofluvial deposits are generally absent in the Prince Rupert area, and have not been mapped. However, small pockets of shallow, loose, glaciofluvial sands and gravelly sands were observed in the valleys of Stumaun Creek and Little Georgetown Creek in areas mapped as units 3 and 1. They may have been deposited in depressions in wasting ice, or they could be remnants of deltas deposited during the period of higher sea level.

Colluvial deposits are common in steep terrain throughout the study area. They most commonly occur as a thin veneer of material derived from till or fractured bedrock on mountain slopes (unit 5). On many slopes, they are subject to debris slides or flows (see section 3.2.3). Some of the schists (bedrock geology unit 2) are easily weathered. Colluvial deposits derived from this weathered material are widespread along the west side of Tuck Inlet and the slopes of the valley between Tuck Inlet and Port Simpson, and mountain slopes on Kaien Island. The texture of colluvial deposits depends on the parent material; most commonly it is an unsorted mixture of angular coarse fragments, sands, and fines. As the schists in the area are prone to break down to fine micaceous sand, this

material is common in colluvial deposits. Colluvial deposits resulting from recent debris slides often contain a high proportion of wood.

Thicker colluvial deposits in the form of fans or aprons are found at the base of many steeper slopes (unit 6). These are formed from accumulations of material from debris slides and flows. Rubbly colluvial deposits, or talus, are found at the base of cliffs (unit 7a). Soils on colluvial deposits are most commonly organic, with some podzols in locally better drained areas.

Deep organic material (muskeg) is found in poorly drained bog areas of the lowlands (unit 8). It is made up of peat derived mainly from sphagnum moss. Shallow bogs are also found in seepage areas on moderately steep (up to 30%) slopes, as well as in level areas and hollows, underlain by bedrock (unit 2a). These blanket bogs are common in the more mountainous areas with high precipitation and massive, low-permeability bedrock. Fens (wetlands with organic deposits derived from sedges) are found along shallow lake margins (unit 9b). They are best developed around Neaxtoalk Lake and are also found in small areas at Bannock Lake and Georgetown Lake.

Over large lowland parts of the study area, thick organic soils (typic mesisols and mesic fibrisols) derived from moss and wood debris have developed. These result in organic deposits of 50 cm or more in depth, and have therefore been mapped as a discontinuous organic veneer. They overlie other surficial deposits (morainal or glaciomarine) or bedrock. In many upland areas, organic soils formed largely from forest litter (folisols) or moss and wood debris (lithic fibrisols) have formed a thin organic veneer over bedrock. These have not been included in the terrain mapping, but are probably present in much of unit 7 and parts of unit 5.

Fluvial deposits are confined to narrow strips along the valleys of the larger creeks (unit 9). They are found in the valleys of Lahon, Little Georgetown, and Denise Creeks and the Shawatlan River, and as deposits too small to map in low-gradient portions of many other creeks. They are

normally sandy gravels with abundant cobbles. Soils are mainly regosols, with some podzols and organic soils.

Small steep fans are found at the mouths of many small creeks (unit 9a). They are formed mainly of material carried down the creek channels in the form of debris torrents.

Small deltas (unit 9b) are found at the mouths of creeks entering Neaxtoalk, Georgetown, and Bannock Lakes. They are formed of sands and gravels, and are generally covered with organic soils.

Several estuaries (unit "E") have been mapped where major streams enter the heads of inlets. This unit has also been applied to the larger areas of tidal flats. Both types of feature have a wide sandy or muddy intertidal zone.

d) SOILS

Soils form as a result of the interaction of climate, vegetation, and gravity acting on bedrock, surficial material and topography over a period of time. The most striking feature of the soils of the study area is their lush vegetation and frequent layers of organic material even on extremely thin, coarse textured material. The climate of the north coast of British Columbia is a major factor in the development of the characteristic soils of the study area. A classification for soil climate has been adopted by the Canadian Soil Survey Committee (1978). According to this system, the entire Tsimpsean Peninsula would be classed as cold cryoboreal for soil temperature and Perhumid for soil moisture. This is an area with a short growing season (less than 180 days over 5°C) and which experiences no significant water deficits. Even well drained areas can support dense vegetation and poorly drained areas quickly fill with mosses and other vegetation that grow in saturated conditions.

The Canadian System of Soil Classification (1978) was used. Soils were described to the Great Group level.

Organic Soils

Organic soils dominate much of the Tsimpsean Peninsula. Organic soils contain 30% or more organic matter by weight and are normally more than 60 cm deep or have less than 10 cm of mineral material separating the organic and bedrock layers. Organic soils are most commonly known as peat, mulch or bog soils.

The majority of organic soils of the study area fall into two Great groups. The first is the Mesisols. These soils are primarily derived from sphagnum and similar mosses under very poorly drained conditions. These areas can be shallow and discontinuous, such as terrain unit 1a or deep and extensive, such as terrain unit 8. These soils develop in areas where mosses are either dominant, such as the bog vegetation type, or where mosses form a significant portion of the understory, such as the Bog Woodland and Bog Forest vegetation types.

The second major type of organic soil is Lithic Typic Folisol. These soils are formed where forest litter layers (LFH horizons) are deposited on thin soils such as the fragmented bedrock of terrain units 5 and 7 and some areas of terrain unit 6. Folisols are normally discontinuously mixed with Ferro-Humic Podzols and occur more frequently at higher elevations. Unlike the Mesisols and other organics, Folisols are often found on crests of ridges, steep areas, and areas of rolling bedrock.

The Organic soils are very variable within the study area. Virtually all the Subgroups in the Organic Order with the exception of the Limno groups, are probably found in the study area.

Podzols

Podzol soils normally develop in well drained coarse material with subarctic to cryoboreal and humid to perhumid soil climates, under coniferous forests. Under these conditions, organic acids and iron and aluminum oxides are translocated down the soil profile to form the characteristically reddish brown Bf horizon. Low pH of 3 to 5 is also a characteristic of Podzols.

In more humid podzol areas, heath and moss understory vegetation develops. Under these conditions a dark brown Bhf horizon develops and the podzols are classed as Ferro-Humic Podzols. Ferro-Humic Podzols are found in the study area on morainal deposits, (terrain units 1 and 3), well drained sandy glaciomarine deposits (terrain unit 4), and to a lesser extent in well drained colluvial areas (terrain unit 5). Ferro-humic Podzols are the dominant soils of the Cedar-Hemlock Forest and Spruce Alluvial Forest vegetation types. Orthic, Placic and Sombric Subgroups of Ferro humic soils occur in the study area. Many of these soils are less than 50 cm thick and are termed Lithic.

Minor Soils

Several soil types occur only in scattered locations in the study area. Regosols are found in very recent colluvial fans, recent fluvial deposits, and some tidal flats. Humic Regosols are the dominant Regosolic Great group.

Brunisols can be found in fairly recent colluvial deposits and limited high elevation areas. Virtually all Brunisols in the study area would be of either the Dystric or Sombric Great group.

3.2.3 Assessment

a) Terrain Sensitivity

Terrain impacts resulting from transmission line construction are essentially the same as those resulting from logging, i.e. road construction and forest clearing. Soil erosion caused by these activities is of concern if sedimentation occurs in streams which are used by fish or for domestic water supplies. Soil erosion can also result in a visual impact. In poorly drained terrain, construction activities can cause disruption of drainage affecting lakes, ponds, and muskeg; changes in water levels, flow, and quality can affect the ecosystems of these areas.

Morainal deposits in the study area (units 1, 2, and 3), are generally coarse-grained and compact, and have favourable stability, bearing strength, and resistance to erosion. Extensive logging has taken place on morainal deposits in the valley system between Port Simpson and Tuck Inlet; impacts related to soil erosion and road construction have been minimal. It should be pointed out, however, that logging has taken place mainly in better drained localities (imperfectly to well drained soils), where podzol rather than organic soils have developed (see section 3.3, Vegetation, and 3.5, Forestry). Some other areas of unit 1 are poorly drained, and tills in these areas may be more subject to soil erosion and instability if disturbed, due to their saturated state. Potential problems would probably be limited to seepage areas with thicker till deposits. Units 1, 2, and 3 are assessed as being of low sensitivity. Unit 3a, which shows some evidence of gullying, is moderately sensitive. Units 1a and 2a, which are the more poorly drained counterparts of units 1 and 2, are also of moderate sensitivity.

Glaciomarine deposits (units 4 and 1b) are sandy, moderately compact, and imperfectly to moderately well drained. Observations in road cuts and construction sites indicate that they are similar to sandy tills in

physical properties, and they are therefore assessed as being of low sensitivity. Areas of fine-grained glaciomarine deposits in depressional areas beneath muskeg are unlikely to be encountered on any of the proposed transmission line routes.

Colluvial deposits (units 5 and 6) in some parts of the study area have properties similar to tills; however, they are less compact and generally occur on steeper slopes. On slopes of over 30%, they can be susceptible to soil erosion, gullying, and small-scale sliding as a result of construction and removal of forest. Some of these features have been noted in logged areas in the pass between Lahon Creek and Georgetown Lake. Construction on steep colluvial slopes could contribute sediment to debris torrents in small, steep channels or trigger larger debris slides.

Many slopes in the study area are subject to debris slides and flows (units 5a and 6a; see following subsection). These slopes are especially sensitive to slope instability as a result of construction. Since slides occur naturally, and apparently randomly, on these slopes, they are considered more of a geotechnical than an environmental constraint.

Units 5, 5a, 6 and 6a are assessed as being of moderate sensitivity. Units 7 and 7a, which consist mainly of bedrock and coarse colluvium at high elevations or on bluffs, are of low sensitivity and are avoided by the corridors.

Organic deposits (peat) are sensitive to construction activities because of their saturated state, susceptibility to erosion, and low strength. Disruption of drainage due to construction can have impacts affecting large areas of a bog ecosystem. Peat normally must be removed from construction sites and replaced with fill; acid leachate waters or flowage of the disturbed material can affect adjacent areas. Because of the hummocky or ridged terrain characteristic of lowlands in the study area, transmission line structures can often be located on locally high ground occurring in areas of muskeg. Adverse impacts result primarily

from road construction. The existing distribution line from Metlakatla to Port Simpson, which was installed by helicopter without a road, has traversed wide expanses of muskeg with minimal impact.

Deep muskeg (unit 8) is assessed as being of high sensitivity, while shallow or discontinuous muskeg (units 1a and 2a) is of moderate sensitivity. Organic soils are more sensitive to disturbance than mineral soils, but they tend to re-establish themselves quickly, as disturbed areas regenerate readily, even on bedrock.

Fluvial deposits (unit 9) are restricted to valley bottoms, and in most cases form narrow bands which are spanned by transmission lines. The deposits are coarse-grained and are stable and have good engineering properties. Impacts related to water resources and fisheries might occur if construction directly affects a channel or interferes with natural processes of channel shifting; apart from the channel, terrain sensitivity is rated low. Flooding may present a hazard in some locations. Steep alluvial and colluvial fans (unit 9a) are small and can generally be spanned by transmission lines. Flooding may present a hazard to roads.

Lake deltas (unit 9b) are assessed as being of high sensitivity because of the organic fen deposits which cover them, and the fine texture of the fluvial material. Delta deposits must normally be covered with fill if road or transmission structure construction is to take place; this is likely to result in water quality impacts to the delta.

Estuaries and tidal flats (unit "E") must be covered with fill before roads, transmission line structures, and other structures can be built on them. This can have a wide range of impacts affecting water circulation, water quality, aquatic ecosystems, and wildlife. Estuaries are therefore considered a very sensitive terrain unit.

b) Terrain Hazards

The Prince Rupert area is well known for the numerous rapid, shallow landslides which occur on steep slopes. These slides have been described and discussed by NEAT (1975) and Clague (1978). They typically involve a thin layer of soil or colluvial material sliding on bedrock, on slopes of 30° or more, and begin at a point and widen downslope. The slides appear to occur randomly with respect to slope orientation and geology. On resistant bedrock such as some massive gneiss, the slides move over bare smooth bedrock, and the debris consists mainly of organic material with a small amount of mineral soil. In most slides though, the underlying bedrock is less resistant foliated schist and gneiss, and the debris includes a larger proportion of weathered rock and mineral soil. The slides can be classified as debris slides, debris avalanches, debris flows, and debris torrents (see Appendix D for definitions); probably the debris avalanche category is the most common.

It is apparent that high precipitation, resulting in the soil overlying bedrock becoming saturated or supersaturated, is an important factor in initiating slides. The slides observed near Prince Rupert have been associated with precipitation events of at least 100 mm in 48 hours, following a longer period of generally wet weather (NEAT, 1975). Such events are fairly common in the Prince Rupert area during the fall and winter. The triggering mechanism for the slides is poorly understood. Windblown trees, small areas of locally intense precipitation in storms, and localized debris torrents in small channels may be triggering mechanisms. At two locations, one above Work Channel, and one above Silver Creek, small incipient slides were observed from the air where a fallen tree had poulled the soil mat and a small area of adjacent trees interlinked by roots away from the rock.

The susceptibility of slopes to slides may have some relationship to geology. On the west shore of Tuck Inlet and the adjacent slope of Prince Rupert Harbour, a large concentration of debris slides and torrents is evident from scars in vegetation. The underlying rock consists of friable, foliated, micaceous schist, and the overlying soil includes 20 cm or so of decomposed bedrock (observed on the logging road near the north end of Tuck Inlet). The layering of the schist dips at about 30° to 40° toward the inlet, roughly parallel to the slope. On the east side of the inlet, where the layering dips into the slope, slides are rare.

Debris slides and avalanches are a hazard to transmission line structures and roads which are built in their path. The random distribution of slides on susceptible slopes makes avoidance or prediction of locations difficult. Debris torrents, which are confined to channels, are easily spanned, although roads are threatened at predictable locations. It is unlikely that road cuts at the base of a slope would trigger debris slides, since they are normally triggered at a point high on a slope. Construction of transmission lines high on a slope, however, could conceivably trigger slides which could threaten a road or pipeline at the base of the slope. There are two locations, one on the west side of Tuck Inlet, and one on the east side of Morse Basin, where logging high on slide-prone colluvial slopes has apparently resulted in small slides.

Areas which appear, from air photo interpretation or field observation, to have been subject to slides in the past (units 5a and 6a), have been mapped as geotechnical constraints. However, all slopes of over 30° should be considered subject to randomly located slides following extreme rainfall events. Steep rock bluffs with associated talus and small rockslides have also been mapped as geotechnical constraints; these features, however, are isolated and easily avoided, and it is unlikely that they would be considered for transmission line or road construction.

The study area is located in Zone 3, the zone of highest seismic risk in Canada. Seismic risk is discussed in DOME (1981, 1982). Deep muskeg, deltas, and estuaries are subject to amplification of ground motion or liquifaction during earthquakes. Other materials provide good foundations for transmission line structures. Earthquakes could trigger slides, particularly in areas where foliated rocks dip or are fractured parallel to steep slopes. Seismic risk is not considered a factor in transmission line corridor selection.

3.3 WATER RESOURCES

3.3.1 Methods

The available literature was reviewed for information on flows, aquatic habitat, and water quality of streams in the study area. References consulted include NEAT (1975) Hinton and Assoc. Ltd. (1975), and Dome (1981). The latter two references rely heavily on information presented in the first reference.

There are no published streamflow data for the study area. Data for the Prince Rupert region are limited to the Kloiya River system which is heavily regulated for water supply, and to sporadic seasonal records for a few streams east of Work Channel. Synthetic hydrographs, derived from precipitation records, are given in NEAT (1975) for several creeks in the study area; these give probable mean and flood flows.

The B.C. Ministry of Lands, Parks and Housing in Prince Rupert (Brodie, pers. comm.) was consulted regarding the Shawatlan River watershed.

All major streams crossed by the proposed transmission line corridors were examined on 1:20,000 air photographs and by helicopter in the field. Where landings were possible, the stream channel in the vicinity of the crossing was examined, and information regarding channel morphology, bed and bank material, and flows was inventoried. A sample of the field check list used for this inventory is given in Appendix F. Lakes and ocean shorelines in the corridors were also examined.

A subjective evaluation was made of the sensitivity of each stream and lake to transmission line construction, using the following criteria:

High sensitivity: a) Terrain susceptible to erosion or mass movement is located in the vicinity of the stream, and

b) the stream contains significant fish habitat (see Section 3.7) or is used for domestic water supply.

Moderate sensitivity: One of the conditions (a) or (b) above, but not both, apply.

Low sensitivity: No significant fish habitat, water use, or sensitive terrain is evident.

Only large streams with perennial flow and alluvial channels for at least part of their length were considered. A large number of small, steep creeks and seasonal watercourses exist in the study area; these were not examined unless they could affect a significant stream to which they are tributary.

3.3.2 Inventory

a) Regional Hydrology

The largest watersheds in the study area are those of the Georgetown Lake system (about 51 km^2) and the Shawatlan River (47 km^2). These two watersheds are dominated by large lakes, which provide a certain amount of natural regulation of flows. Woodworth Lake, on the Shawatlan River, is dammed as part of the Prince Rupert water supply system. Five other watersheds of intermediate size, between 13 and 27 km^2 in area, are crossed by the corridors; these are Stumaun Cr., Lahon (Pearl Harbour) Cr., Silver Cr., Denise Cr., and an unnamed creek entering Morse Basin at Butze Rapids. The watershed of Neaxtoalk Lake, although only about 2 km^2 in area, is included in the inventory because of its unusual hydrology and its biological importance. The streams examined are listed in Table 3-3 and shown on Map 4; this inventory also includes several tributaries of large watersheds where these are directly affected by the proposed corridors.

The annual flow regime of streams in the study area is typical of low elevation areas on the north coast, where most precipitation falls as rain, with most of the rainfall occurring in the fall and early winter. Streams with watersheds lying mainly in the coastal lowlands, such as Lahon Creek and the west fork of Stumaun Creek, have little storage of water in the form of snow, and the maximum discharge coincides with the rainy season in fall and early winter. Streams which drain high elevation areas, such as Denise Creek and the upper Shawatlan River, have considerable snowpacks in their watersheds in winter, and thus have a season of maximum flow in spring. Most streams in the study probably show two seasonal maxima, with one peak in October and a second in May. All streams in the study area can be expected to experience their maximum flood events in response to heavy fall rainstorms.

Synthetic hydrographs derived from precipitation (which is estimated very approximately for the upland areas), assumed evaporation, and watershed topography, are presented in NEAT (1975) for Stumaun Creek east and west forks, Lahon Creek, and Georgetown Creek above Georgetown Lake. Flood flows for various return periods and mean monthly flows are estimated for each of these creeks. In the absence of flow measurements and channel surveys, these estimates are the best information available on mean and flood flows for streams in the study area. Flow estimates from this source are included in Table 3-3.

Most of the upland portion of the study area consists of bedrock with very thin surficial deposits, covered with thin organic soils which are saturated for most of the year. Watersheds draining these areas, therefore, can be expected to respond rapidly to rainfall, resulting in extreme and rapid fluctuations in discharge. Lowland areas contain considerable areas of muskeg; this would tend to provide considerable water retention, moderating discharge fluctuations to some extent, particularly in summer. However, because of high water tables in fall and winter, these watersheds would also be expected to show a rapid response to rainstorms in these seasons.

Most of the large streams have reaches of alluvial channels in their lower parts, consisting mainly of coarse gravel and cobbles. Steeper channels in headwaters reaches, and channels of small streams, typically are bedrock controlled and have beds and banks of bedrock, boulders, and cobbles. Surficial deposits through which the streams cut are mostly thin, discontinuous, coarse-grained colluvium and till. The suspended sediment load of most streams is therefore probably low except during floods, and bedload consists mainly of coarse material moved only during floods. Debris flows, to which most watersheds are susceptible during rainy periods, can be expected to introduce large quantities of coarse and fine sediment on rare occasions. Most streams in the study area, particularly those draining lowland watersheds, are stained brown as a result of seepage from organic soils. Water quality information reported in Hinton and Assoc. Ltd. (1975) indicates that stream water in the area is slightly acid and has low dissolved solids concentration.

The alluvial lower reaches of the large streams commonly have islands, split channels, and numerous gravel bars; these features are often related to logs in the channel. These channels show evidence of bank undercutting and of channel shifting during extreme discharge events. The floodplain areas are generally heavily vegetated with coniferous forest and alder, which protects the banks from erosion during normal and moderately high flows. Some small, steep creeks have steep fans at their mouths: these creeks are prone to channel shifting during floods. In almost all other reaches, stream channels are bedrock or lag-boulder confined and are both laterally and vertically stable. Very small creeks frequently have banks of peat. Many small, steep creek channels are occasionally swept by debris torrents.

b) Streams Affected by Corridors

The channels of streams listed in Table 3-3 were examined in the field at the approximate locations of proposed transmission line corridors, as indicated on preliminary route maps provided by B.C. Hydro. Observations

are summarized in the table, and are described here in approximate south-to-north order.

The unnamed creek entering Morse Basin from the east at Butze Rapids is hidden by overhanging vegetation in the area of the corridor crossing (Morse Basin East). Where visible closer to its mouth, it appears to have a narrow, bedrock-confined channel, with organic soils exposed along its banks. A small area of alluvial (cobble and coarse gravel) bed is visible at its mouth.

Denise Creek flows though a fairly wide (100 - 150 m) alluvial floodplain for its lower 1.5 km. Its bed is largely cobbles with some areas of gravel, and the channel shows an irregular, split pattern which is subject to shifting during floods. The major tributary entering Denise Creek from the north has a steep, bedrock and boulder channel which is subject to debris torrents. In its upper portion, where it adjoins Bannock Lake, it flows through a small area of alluvial deposits; there are beaver dams in this area.

The short reach of the Shawatlan River between Shawatlan Lake and its mouth flows over ridges of exposed bedrock, forming a set of rapids. The bed here is largely cobbles and boulders. Above Shawatlan Lake, the river flows in an alluvial channel for about 2 1/2 km, with a gravel and cobble bed. The channel appears stable, due to the regulating effect of Woodworth Lake. From the Woodworth Lake dam to the major bend at the head of the alluvial section, the river is steeper with a boulder-cobble bed and steep valley walls.

The trbutary entering Woodworth Lake from Mahlon Lake is steep, with a bed and banks of boulders, cobbles, bedrock, and logs. It is flanked by steep colluvial slopes and may be subject to occasional debris slides.

Silver Creek, for its lower 1.5 km, flows in a narrow alluvial floodplain bounded by very steep valley walls consisting of bedrock thinly mantled by colluvium and glacial drift. The channel is occasionally confined at

bends by the valley walls. It has a gravel and cobble bed, and although it is probably subject to rapid fluctuations in flow, it shows minimal evidence of channel shifting. The estuary of the creek fills most of Laurier Cove.

Georgetown Creek, between Little Georgetown Lake and Georgetown Lake, flows through a narrow, bedrock-confined channel which is mostly concealed by forest. Downstream from the major bend, where the transmission line corridor crosses, the gradient lessens and it flows through long pools separated by short gravel riffles and bedrock rapids. Except near its mouth, it is bedrock-controlled. At the mouth, there is a short reach of fine gravel and sandy delta deposits.

Above Little Georgetown Lake, the creek flows for about 2 km through a flat area which is a complex of alluvial deposits, coalesced alluvial and colluvial fans from side valleys, and small wetlands. The creek flows through an irregular, low-gradient channel with long pools and a gravel bed, and forms a marshy delta where it enters Little Georgetown lake. This area has been recently logged, and all trees have been removed to the water's edge. The channel in its natural state appears fairly stable, with some lateral migration resulting from bank undercutting; logging, with the removal of bank vegetation cover and the addition of logs and debris to the channel, is probably resulting in an increase in lateral activity.

The creek entering Georgetown Lake from the northeast has built a steep alluvial fan into the lake; there is a small area of gravel-bed channel at its mouth. Otherwise, the channel is steep and tumbling, and is confined by bedrock.

Lahon Creek, for about 4 km below where it is crossed by the corridor, flows in a low-gradient, gravel-bed channel with abundant bars and an irregularly meandering pattern. Its valley has been heavily logged in the past, which has possibly contributed to increased channel activity; however, the banks are becoming vegetated by alder and the creek channel

appears to be fairly stable, with only slight evidence of bank erosion. A logging road bridge crosses just downstream from the proposed transmission line crossing. This crossing occurs near the upstream limit of the alluvial channel; at this point, the bed is mainly cobbles with steep morainal banks; upstream, the creek occupies a steep bedrock-boulder channel.

The west branch of Stumaun Creek is a gravel-bed stream in its lower part, similar in characteristics to Lahon Creek. It has also been affected by logging in the past, and the logging road is very close to the channel. The proposed transmission line route crosses the creek and a major tributary over narrow, bedrock-confined channels about 0.5 km above the alluvial channel. The larger east branch of Stumaun Creek is steep, with a bedrock-boulder-cobble bed and numerous small waterfalls.

The preliminary route location map shows the line crossing below or above Neaxtoalk Lake. The short section of creek draining the lake is a narrow, shallow canyon cut in bedrock, with a bedrock-boulder bed. This channel is tidal, with the direction of flow reversing at extreme high tide. The short section of channel between lower and upper Neaxtoalk Lake is marshy, with bed and banks of organic material and sand or mud.

c) Lakes

Bannock and Mahlon Lakes are small, subalpine lakes situated in a boggy pass. They are largely surrounded by bogs, and have some shorelines which are a mixture of bog, sedge marsh, and bedrock.

Woodworth Lake has steep, mountainous shorelines, with a small sand and gravel delta where the tributary draining Mahlon Lake enters it, and a large marshy delta at its east end. It has been raised by a man-made dam and experiences some fluctuation in water level.

Georgetown Lake has a moderately steep shoreline of shallow morainal material and bedrock, with a marshy, sandy delta at either end. It was raised slightly (probably less than 1 m) by a now broken man-made dam at

its outlet. Little Georgetown Lake has a steeper shoreline of bedrock and colluvial deposits, with a large marshy delta at its upper end.

Neaxtoalk lake is hydrologically unique in the study area in that it is slightly below extreme high tide level, and thus experiences infrequent rises in water level and introduction of brackish water. This has apparently inhibited the growth of muskeg (spaghnum bog) around its shores (NEAT, 1975). The shoreline along its eastern end, and the flat area joining it with the smaller lake to the northeast is bordered by sedge marshes and underlain by organic fen deposits.

d) Ocean Shorelines

The shorelines throughout the study area are dominated by bedrock, with thin beaches of lag boulders and cobbles derived from morainal material. Morse Basin and the north side of Denise Inlet feature rock headlands separated by gravel-cobble beaches, with broad tidal flats in sheltered bays. These tidal flats are sandy in the lower intertidal zone with gravel-cobble beaches near the high tide line. Major estuaries, with sand and mud flats and tidal marsh vegetation, are found at the mouths of Denise Creek and the Shawatlan River.

Prince Rupert Harbour and Tuck Inlet have straighter, but still fairly sheltered, shorelines. Steep bedrock-boulder shores alternate with narrow gravel-cobble beaches and occasional narrow tidal flats. A major estuary is located at the mouth of Silver Creek.

The shoreline of Work Channel is mainly steep bedrock, with small gravel-cobble beaches at a few sheltered locations, particularly Zumtela Bay. The shoreline of Port Simpson Harbour is largely bedrock with narrow cobble-boulder beaches, and a few small sand-gravel beaches in sheltered coves between headlands. Stumaun Bay is a wide, sheltered estuary with sand and mud tidal flats.

3.3.3 Assessment

Impacts on streams can result from road building and clearing of vegetation during transmission line construction. These activities, if carried out near channels or lakeshores, can cause sediment to be released into the stream system. Soil erosion along roads or on the cleared right-of-way can result in continued sediment production following construction. Sensitivity of streams and lakes to transmission line construction, therefore, depends on the susceptibility of the terrain adjacent to the channel or lakeshore to soil erosion and mass movement. It also depends on the value of the watershed as fish habitat or for domestic water supply.

The tributary of Woodworth Lake draining Mahlon Lake is of high sensitivity because it is bounded by steep slopes which must be traversed by a transmission line and which are subject to possible debris slides and soil erosion. Sediment added to this creek could have an impact on the quality of Prince Rupert's water supply, which originates in Woodworth Lake. The crossing of the Shawatlan River below the Woodworth Lake dam is of moderate sensitivity (see Section 5.0).

Silver Creek is highly sensitive to disturbance, because of its narrow valley bottom bounded by steep, potentially unstable slopes, and its value as a salmon stream.

Neaxtoalk Lake, and the wetland area to the northeast, are considered highly sensitive because of the delicate hydrologic balance and unusual ecology of the lake system. The creek below Neaxtoalk Lake is of moderate to low sensitivity.

The estuaries of Denise Creek, Shawatlan River, Silver Creek, and Stumaun Creek are of high sensitivity, as are the freshwater deltas of Georgetown Lake. These have been rated as sensitive terrain units (see Map 1).

Denise Creek, Lahon Creek and the west fork of Stumaun Creek are considered to be of moderate sensitivity. These streams have significant salmon runs; however, the terrain adjacent to the streams is not especially sensitive to disturbance, provided the standard precautions required when crossing or building adjacent to salmon streams are observed.

The Georgetown Creek system is relatively insensitive to disturbance. It has no anadromous fish populations, and the terrain along Georgetown Lake and Georgetown Creek above the lake is not sensitive to disturbance. The crossing of upper Georgetown Creek above Little Georgetown Lake is more sensitive to soil erosion and mass movement; however, this area has been recently denuded by logging, and no additional impacts would be expected from the transmission line construction.

TABLE 3-3. HYDROLOGY AND CHANNEL DESCRIPTIONS

Stream	Watershed Area (km^2)	Crossing km Above Mouth [a]	Approx. Discharge (cm^3/s) Mean [f]	Bankfull [g] (2-yr Flood)	100 yr Flood [e]	Channel slope at Crossing [g]	Approx. Width at Bankfull Stage (m)	Bed Material [k]	Bank Material [k]	Remarks
Denise Creek	27	—	2.8			0.018 [h]	8 to 20	Cobble, Gravel	Alluvial	Not crossed by route, but route enters lower part of valley.
Unnamed Tributary of Denise Creek	11	1, 2.5 [d]	1.1			0.051, 0.10	n.v.	Bedrock, Boulders Cobbles, Logs	Colluvial, Bedrock	Slide Debris in channel.
Unnamed Creek at Butze Rapids	13	0.5	1.2			0.076	n.v.	—	—	Creek hidden by forest at crossing; possibly bedrock confined. Bedrock and peat along banks at mouth.
Shawatlan River	47	0, 2 [c]	4.8			Tidal, 0.023	Estuary, 50 to 150; Upper n.v.	Cobbles, Gravel (Upper Crossing)	Morainal, Alluvial (Upper Crossing)	Proposed lower route crosses narrows at estuary mouth. Upper river is in alluvial channel below crossing. Prince Rupert water supply watershed.
Woodworth Lake Watershed above Dam	25	—	2.7			—	—	—	—	Prince Rupert water supply watershed.
Unnamed Tributary of Woodworth Lake	4	1	0.4			0.087	n.v.	Boulders, Cobbles, Logs	Colluvial, Bedrock	Steep tumbling channel.
Silver Creek	20	0	2.0			Tidal	8 to 12 Above Mouth	Gravel, Cobbles	Alluvial, Colluvial	Proposed route crosses estuary. Descriptions refer to channel above mouth.
Georgetown Creek Above Georgetown Lake	35	2, 7 [c]	3.2 [e]	16	31	0.016, 0.010	n.v., 8 to 10	Gravel (Upper Crossing)	Alluvial (Upper Crossing)	Lower crossing hidden by forest; possibly bedrock confined. Upper crossing area affected by recent logging.
Unnamed Tributary of Georgetown Lake	5	0.2	0.4			0.20	n.v.	Bedrock, Boulders	Colluvial, Bedrock	Steep creek with gravelly fan at mouth.
Lahon Creek	19	5	1.0 [e]	15	32	0.014	4 to 8 above [j]; 8 to 20 below	Gravel, Cobbles	Colluvial, Morainal	Wider and less steep below crossing with alluvial banks; past logging.
Stumaun Creek, West Branch	5	1, 2.5 [b]	0.4 [e]	3	10	0.044, 0.038	3 to 5 In Lower Part	Gravel, Cobbles	Alluvial, Morainal	Irregularly meandering in lower part; steeper and narrower where crossed by route; past logging.
Stumaun Creek, East Branch	9	0.5	0.8 [e]	6	11	0.076	n.v.	Cobbles, Boulders	Bedrock, Some Morainal	Steep channel with small waterfalls.
Neaxtoalk Creek	2	0.1	0.1			Tidal	n.v. [i]	Bedrock, Cobbles	Bedrock	Tidal; reverses flow at extreme high tide.

a. Approximate location from B.C. Hydro preliminary map.
b. Two forks crossed. Data given for east and west forks, respectively.
c. Crossed by two corridors. Data given for lower and upper crossings, respectively.
d. Crossed twice. Data given for lower and upper crossings, respectively.
e. Discharge estimates from NEAT (1975).
f. Other mean discharges from unit runoff estimates given in NEAT (1975).
g. From topographic map, 100 ft contour interval.
h. Mouth to 100 ft contour.
i. n.v. = not visible on air photos.
j. Channel widths upstream and downstream from crossing.
k. Observed in field.

3.4 VEGETATION

3.4.1 Methods

a) Approach

The description and mapping of the vegetation features along the proposed transmission line corridors were based on the following sources:

1. Published vegetation reports
2. Forest cover maps (1:20,000)
3. Discussions with informed parties
4. Air photographs
5. Limited field checks

Two levels of integration were chosen for the classification and description of the vegetation, namely, the biogeoclimatic zone and vegetation type.

A biogeoclimatic zone (Krajina, 1965) is a large geographic area that has a broadly homogeneous macro-climate, and consequently has characteristic webs of energy flow and nutrient cycling, and exhibits similar patterns of soil and vegetation. It provides the framework in which more detailed vegetation communities can be classified for future detailed studies. Zones are characterized by closely related, climatic climax or zonal ecosystems. Zonal ecosystems are described mostly in terms of typical vegetation and prevailing soil-forming processes. Zones are usually named by one or more of the dominant shade-tolerant tree species that are usually capable of self-regeneration on most of the habitats. At the zonal level, the biogeoclimatic system is essentially a classification of macro-, or regional climate, but relies also on the parameters of climatic climax vegetation and zonal soils or pedogenic processes, which are themselves, to a large extent, products of macro-climate.

Vegetation types were described and mapped within the biogeoclimatic zone. The vegetation types were defined using the major structural features of the vegetation along with topography and drainage.

In addition to these vegetation features, special features such as Ecological Reserves, Ecological Reserve applications and unique vegetation types were also identified.

b) Mapping and Field Methods

Forest cover maps and existing vegetation mapping in conjunction with aerial photographs were utilized to identify the biogeoclimatic zones and vegetation types.

A three-day field reconnaissance was carried out including a one-day helicopter flight to establish sample plots and field check the initial vegetation mapping. Areas with unique vegetation were also identified and investigated.

Subjectively chosen sample sites were located within the vegetation types along the various transmission line corridors. The sample sites were chosen in "homogeneous" stands that best represented the vegetation. This has been proven to be a reliable method (Mueller-Dombois and H. Ellenberg, 1974). At each sample site, physical site and vegetation data were collected using criteria outlined in "Manual for Describing Ecosystems in the Field" (1980). This information was used to describe the vegetation and assess its sensitivity to development.

The scientific and common names of the plant species mentioned in the text are shown in Appendix E. Where common names do not exist, as with the mosses, only scientific names are used. Nomenclature is according to Taylor and MacBride (1977), for vascular plants, and Lawton (1971) for the mosses.

3.4.2 Inventory

The study area falls mainly within the Coastal Cedar-Pine-Hemlock Biogeoclimatic zone (CCPH) (Pojar, 1980). This zone occurs from sea level to 400 m. Above this elevation the Mountain Hemlock Biogeoclimatic zone (MH) is found.

The CCPH zone is characterized by a cool, wet climate throughout the year. Dry sunny periods are rare. The mean annual temperature ranges from 7.5 to 9.5° C. No month has a mean temperature below 0°C. Mean annual precipitation ranges from 1430 to 3000 mm.

The dominant tree species are western red cedar, yellow-cedar, western hemlock, shore pine, Sitka spruce and red alder. Amabilis fir and mountain hemlock frequently occur in the upper portions of this zone.

The vegetation of the study area is dominated by mature and overmature timber stands interspersed with areas of bogs and bog woodlands. The transition from bog to forest is usually associated with increasing slopes and decreasing peat depth (Neiland, 1971). Deep mineral soils which are seldom found in the study area generally support highly productive cedar-hemlock or spruce forests. These are found along stream courses where fluvial landforms are prevalent. The climax forest of the CCPH zone is dominated by red and yellow cedar with lesser amounts of western hemlock, shore pine and occasionally mountain hemlock (Pojar, 1980). In the nutrient deficient soil types (generally organic) with the most oceanic climate, bog forests tend to be the climax type.

A characteristic feature of the CCPH is the abundance of bogs in the landscape. Depressional and flat bogs are widespread over the flat to gently rolling portions of the lowlands. Sloping and blanket bogs are also common throughout on gentle to moderately slopes (10 to 30%).

Marshes and fens also occur in the zone, but are localized along flowing water and lake margins.

The following vegetation types occur in the study area and are presented on Map 2. Similar vegetation types have been described by NEAT (1975), Pojar (1980) and Dome Petroleum Limited (1981).

a) Bogs

Bogs are abundant in the study area and occur on either flat or gently sloping land. They may be either blanket bogs, covering the terrain as a thin peat layer, or raised bogs which have a raised centre and slope toward the edges. The latter may have started in basins which once held lakes. Peat deposits in such areas can be deep (greater than 5 m).

Bogs contain a large number of plant species in comparison to the other vegetation types found in the study area. The surface of the raised bogs generally contain open pools with aquatic vegetation such as yellow water lily, bog bean, and pond weed.

The tree species occurring in the bogs are usually stunted forms of predominantly shore pine and yellow cedar with minor amounts of western hemlock and red cedar. Shrubs are abundant, some of the more common ones are Labrador tea, bog blueberry, common juniper, bog rosemary, lingonberry, sweet gale and crowberry. Characteristic herbs include cloudberry, sundew, burnet, goldthread, white gentian, starflower, skunk cabbage and deer cabbage. In addition to these forbs, several sedge species, cotton grass and tufted deer-grass occur commonly in the bogs. The bryophyte layer consists overwhelmingly of Sphagnum species

Sphagnum species but other mosses such as Dicranum sp. and Polytrichum spp. do occur. Lichens such as Cladonia and Cladina spp. are found in raised hummocks in the bog.

b) Bog Woodland

This vegetation type represents a transition from the bog to a forested environment. The tree strata are open, stunted and unevenly aged, rarely more than 5 m in height. Yellow cedar, shore pine and red cedar are dominant. The general structure and species composition of the understory is similar to that of the bog.

c) Bog Forests

The bog forest is characterized by a semi-open to closed forest canopy composed of red and yellow cedar with lesser amounts of western hemlock. This type occurs in an upslope position above the Bog Woodland type. Slopes vary from 20 to 35%. Western hemlock is usually the dominant regeneration because of its shade tolerance. Trees are usually less than 15 m in height.

The understory is very well developed because of the open nature of the forest canopy, thus forming a dense, thicket type understory. Salal, blueberry, false azalea, red huckleberry and Labrador tea are the dominant shrubs. The herb layer is not well developed because of the thick shrub layer. Ferns such as clear fern are common along with false lily-of-the-valley, foam flower, triagblade orchid, dwarf dogwood and goldthreads.

Rhytidiadelphus loreus and Hylocomium splendens dominate the well-developed moss layer, and there often are significant amounts of Sphagnum girgensohnii and Mnium glabrescens.

d) Cedar-Hemlock Forests

Cedar-hemlock forests generally have a closed forest canopy and are the most productive in the study area. This type is found on moderately steep to steep, colluvial slopes where abundant seepage water drains away rapidly. Red cedar and Western hemlock dominate the overstory with lesser amounts of yellow cedar. Amabilis fir is frequent at the upper elevations of this zone. Where western hemlock is the dominant tree overstory, the productivity of the area is high.

The shrub layer consists of blueberry, red huckleberry, false azalea and salal. This layer is moderately to well developed. Typical herbs include deer fern, foam flower, dwarf dogwood, twisted stalk, tureyblade orchid and wood fern. The well-developed moss layer is dominated by Rhytidiadelphus loreus and Hylocomium splendens, and frequently includes Stokesiella oregana, Mnium glabrescens, and Pellia neesiana.

e) Spruce Alluvial Forests

Spruce alluvial forests are found along stream courses where coarse-textured alluvial deposits are prevalent. Sitka spruce and western hemlock with lesser amounts of red cedar are the dominant overstory species. Red alder is frequent on recently flooded or disturbed sites. The shrub layer is dense and composed of false azalea, blueberry, salmonberry, red elderberry, and devil's club. The herb layer contains many species. Typical species include deer fern, dwarf dogwood, false lily-of-the-valley, goldthread, skunk cabbage, foam flower and ladyfern. The moss layer also contains a large number of species but only a few have a significant coverage. These are Mnium glabrescens, Hylocomium splendens, Rhytidiadelphus boreus, Sphagnum girgensohnii and Pella neesiana.

f) Disturbed Areas

Numerous areas occur throughout the study area that have early successional vegetation as a result of past disturbance, mainly logging. The majority of these areas are presently vegetated with red alder and a dense understory of salmonberry. In some valley side locations along Stumaun and Lahon Creeks, thick stands of western hemlock prevail with scattered shrubs such as salmonberry, red huckleberry, blueberry, false azalea, red alder and red elderberry.

g) Tidal Marshes

The marsh areas at the head of Denise Inlet and Laurier Cove are the only two significant tidal marsh areas within the limits of the study corridors. Three different marsh communities were recognized in this study and described in previous studies (NEAT, 1975). The communities and their associated species are:

Alkaligrass - Sea Plantain Zone (Puccinellia spp. - Plantago maritima).

This zone is usually inundated by high tides and in addition to the above species is characterized by scurvy grass, seablite , sea spurry, pickleweed, orache and sea arrowgrass.

Hairgrass - Sedge Zone (Deschampsia caespitosa - Carex lyngbyei)

This zone is occasionally inundated by high tides. In addition to the above species, red fescue, bentgrass, sea barley and Baltic rush make up the species complement of this community.

Grass - Forb Meadow

This zone is infrequently inundated. Its characteristic species are limegrass, Nootka bluejoint, hairgrass, bluegrass, holygrass, Pacific brome, Lyngbye's sedge, chocolate lily, silverweed, yarrow, bedstraw, yellow paintbrush, water hemlock, beach lovage, sea watch, aster and Pacific clover.

3.4.3 Assessment

Impacts to vegetation as a result of transmission line construction, operation and maintenance are related to the scientific value or significance of the vegetation in maintaining the biological stability of a particular ecosystem. Secondary impacts as a result of loss of wildlife habitat or an increase in erosion potential are also possible effects of transmission line development once the vegetation is removed or altered. In addition, all transmission line impacts to vegetation are considered negative since they represent a complete removal or modification of the original vegetation pattern, and therefore a change in the ecosystem dynamics. Consequently, the focus of this impact assessment is to identify the most sensitive habitats and their location. Mitigation options can then be suggested to lessen any adverse impacts. These can either be complete avoidance or some form of engineering practice that will minimize the area disturbed or rehabilitate the disturbed area.

With these concepts in mind, the sensitivity of the transmission line on vegetation were assessed on a three point scale namely High, Moderate, and Low. The sensitivity scale levels were derived subjectively based on intrinsic vegetation characteristics and their sensitivity to transmission line construction, operation and maintenance. These vegetation characteristics were determined from field study and the known species composition of similar habitats reported in other studies. Each sensitivity level has a progressively greater impact on the vegetation resources both at the plant species and community levels.

In order to evaluate each corridor, it was first necessary to rate each vegetation unit as to its importance or sensitivity. This was done using the intrinsic vegetative characteristics of each vegetation type. These vegetation characteristics were determined from the field study and the known species composition of similar habitats found in other studies. Each vegetation unit has been scored for six qualities; the higher the number, the more valuable the vegetation type. Occurrence of the

vegetation type within the study area is easy to evaluate. For example, the Bog Forest and Cedar-Hemlock Forests are common types and cover large areas, while the Spruce Alluvial forests are relatively uncommon and of small extent. Floristic diversity is an estimate of the number of plant species present and the equitability with which the individual plants in a type are distributed into different species derived from the field studies. The vegetation types also differ in their structural complexity and diversity within themselves. This is vegetational diversity. The Cedar-Hemlock forests have a simple pattern compared to the more complex bogs.

Productivity estimates are qualitative assessments of the bio-mass production of an association. For example, the productivity of the Tidal Marshes are high; of Bog Forests extremely low. The forest types, though they may have a high biomass, generally have a low productivity. The potential occurrence of rare or uncommon plant species relies on the field studies, the investigator's knowledge of the flora of the study area, and discussions with people knowledgeable with the vegetation of the area to estimate the vegetation type that is most likely to contain rare or uncommon species. The direct impact of development would be indiscriminate in the effect on the vegetation. Certain secondary disturbances, such as road building, and interception or impedance of drainage would affect some vegetation types more than others (i.e. tolerance to development caused by disturbance).

Table 3-4 shows the results of this analysis. Using the table, the vegetation units can be assigned sensitivity levels. This ranking illustrates the potential impact that the construction of a transmission line may impose. This ranking is shown below:

High sensitivity:	Bogs/bog Woodland
	Tidal Marshes
Moderate sensitivity:	Spruce Alluvial Forests
Low sensitivity:	Cedar-Hemlock Forests
	Disturbed areas
	Bog Forest

Table 3-4. Intrinsic Vegetation Properties and Qualities

Vegetation Unit	Occurrence Within the Study Area	Floristic Diversity	Vegetational Diversity Within Map Unit	Productivity	Occurrence of Rare or Uncommon Species	Tolerance to Devel-opment caused Disturbance	Total
	1-4	1-4	1-3	1-4	1-4	1-4	6-23
Bog/Bog Woodlands	1	4	3	1	4	4	17
Bog Forest	1	2	2	2	2	1	10
Cedar-Hemlock Forests	1	1	2	3	1	1	9
Spruce Alluvial Forests	4	2	1	4	2	2	15
Disturbed Areas	2	2	2	3	1	1	11
Tidal Marshes	4	3	2	4	2	3	18

High sensitivity - 17-23
Moderate sensitivity - 12-16
Low sensitivity - less than 11

Table 3-5 outlines the amount of each vegetation type in each corridor and the overall impact based on the amount (%) of each vegetation type and its sensitivity (Table 3-4). The Work Channel and Denise Inlet-Woodworth Lake corridor segments are the only ones that have been rated as moderate. The remaining segments have been rated as low impact. While the overall impact for the various segments has generally received low to moderate rating, all segments contain vegetation types that should be avoided or otherwise mitigated.

Table 3-5. Summary of the Vegetation Types Found Within Each Corridor Segment

CORRIDOR SEGMENTS	CORRIDOR LENGTH (km)	VEGETATION TYPES (%)						Overall Impact
		Bog/Bog Woodland	Bog Forests	Cedar/ Hemlock Forests	Disturbed Areas	Spruce Alluvial Forests	Tidal Marshes	
Kloiya Bay	2.3	-	10	90	-	-	-	Low
Morse Basin West	12	10	20	70	-	-	-	Low
Morse Basin East	10.7	4	15	85	<1	-	-	Low
Denise Inlet - Woodworth Lake	15.7	12	35	51	2	-	<1	Moderate
Shawatlan Lake	3.3	3	77	20	-	-	-	Low
Laurier Cove	3.7	1	64	35	-	-	<1	Low
Tuck Inlet West	9.5	<1	21	76	3	-	-	Low
Tuck Inlet East	8.0	1	28	65	6	-	-	Low
Georgetown Lake - Port Simpson	18.3	4	42	46	8	<1	-	Low
Work Channel	20.0	11	78	6	5	-	-	Moderate

3.5 FISH

3.5.1 Methods

Fish of regional economic importance including anadromous (pink, coho, sockeye, chum and chinook salmon, and steelhead trout) and inland (Dolly Varden and cutthroat trout) species were emphasized in the study.

Existing information concerning each species habitat utilization and estimated escapement statistics in the proposed transmission line corridor areas was summarized and reviewed by watershed. Literature reviewed included environmental studies completed as part of the Prince Rupert LNG bulk loading facility proposal (Hinton et al 1975 and NEAT 1975). No fish production capability maps were available. Federal Fisheries escapement statistics and maps were used as the basis for stream importance ratings for anadromous fish.

Personal interviews and correspondence with B.C. Fish and Wildlife and Federal Department of Fisheries and Oceans provided information on population status, stream importance, government concerns for fish populations and habitats and possible mitigative alternatives to lessen impacts of powerline construction.

Fish sampling statistics were available for the Kloiya Bay drainage and were used as an example of stream productivity for the study area. Potential stream crossings were identified during a two-day helicopter reconnaissance.

All important stream crossings and parallels were then categorized according to importance of the resource, its sensitivity to disturbance and the likelihood of impacts given the range of possible mitigative actions.

Sensitivity to disturbance was rated as low, medium and high. This depended on potential proximity of construction roads and alignment of the transmission line, amount of paralleling of water courses, and presence of unstable slopes capable of mass movement or significant erosion.

The potential uses of construction scheduling, road and transmission line design, specific construction techniques and artificial aids to fish production were analyzed to determine if impacts could be mitigated.

Potential impacts were grouped by location (stream, estuary or lake), and then given final subjective ratings of low, medium and high. Any further analysis would not be warranted given the quantity and quality of existing data.

Gaps in existing data were identified and recommendations were made for further study.

Some general life history information has been given for each species. This information emphasizes reproductive chronology for the purpose of identifying critical periods (such as spawning, incubation, hatching and emergence of fry) when construction in adjacent areas should be limited in order to prevent siltation and subsequent mortality.

3.5.2 Inventory

Each waterbody was considered separately, in the order of its importance. Reference is made to estimates, species abundance, and diversity (Table 3-6).

Table 3-6. Estimated Importance of Fish Producing Waterbodies in the Proposed Corridors.*

	SPECIES							
	SALMON					TROUT		CHAR
WATERBODIES	PINK	COHO	CHUM	CHINOOK	SOCKEYE	STEEL-HEAD	CUT-THROAT	DOLLY VARDEN
Silver	S	S	S			S		
Denise Cr.	S	S	S			P		
Shawatlan Cr. & River	S	S		S	M	P	P	P
Stumaun Cr.	S	S				P	P	P
Lahon Cr.	M	S				P	P	
Georgetown Cr. & Lake						P	P	P
Shawatlan Lake						P	P	P
Woodworth lake							P	

M = Major significance, > 5,000 escapement for sockeye, chinook, and coho, and > 25,000 for pink and chum

S = Significant, 1,000 - 5,000 escapement for sockeye, chinook, and coho, and 5,000-25,000 for pink and chum

P = Present, numbers unknown

* From Federal Fisheries files, Prince Rupert Office, 1982.

Silver Creek

Silver Creek flows into Tuck Inlet at Laurier Cove. The cove provides good habitat for juvenile pink (Oncorhynchus gorbushca) and coho (O. kisutch) salmon. Pink salmon utilize gravel beds from just above the intertidal zone to a point approximately 2 km upstream, where the first major tributary flows in from the south. Spawning begins in August and continues into October. The hatch occurs from December to February, with the fry emerging in April and May. Juveniles remain inshore near the estuary for the summer, surface feeding on copepods, euphasids, amphibians and a diversity of larvae. These juveniles then move offshore for the winter, returning in June two years later.

Federal fisheries stream surveys have located from 350 to 1200 spawning pinks on a single day. Total average escapement has been estimated at between 5,000 and 25,000; a significant run.

Coho salmon utilize gravel beds 2 km upstream from the estuary. Spawning occurs in October and November, with the fry emerging in April. These fish stay in the stream for a year before their seaward migration. Juveniles remain in the estuary and nearshore areas throughout the summer, feeding on herring larvae and sand lance. Some juveniles remain inshore to mature, while the rest migrate out to sea, returning to spawn as three year olds.

A Federal Fisheries stream survey has located approximately 400 spawning Coho on a single day. Total average escapement has been estimated at between 1,000 and 5,000; a significant run.

Chum salmon (Oncorhynchus keto) spawn in September near the creek mouth and in the intertidal zone on gravel flats. Fry hatch in April and May, moving seaward immediately. They spend the spring and summer in the estuary feeding on copepods and tunicates, then migrate to the open ocean where they stay for three to five years.

Federal fisheries stream surveys have estimated an escapement of from 5,000 to 25,000; a significant run.

A spot check of Silver Creek during the September field reconnaissance revealed the presence of approximately 50 spawned out pinks in the lower 150 m of the creek. Some coho were also present. No chums were seen, as they generally spawn later in the fall.

Denise Creek

Denise Creek flows into Denise Inlet at the southeastern end of Morse Basin. It supports significant runs of pink, chum (both between 5,000 and 25,000 escapement) and coho (between 1,000 and 5,000 escapement) salmon, in the first 1.5 km of the creek (based on unpublished Federal Fisheries surveys 1970 to 1981).

Ample juvenile rearing habitat for these three species is available in the shallows of the estuary and inlet. Spawning beds are located on flat sections of meanders between small riffles.

A spot check during the September field reconnaissance revealed 20 pink salmon in the first 250 m of the creek. Fisheries surveys have shown populations of less than 50 on average of each species for single day surveys.

Shawatlan Drainage (Creek, Lake and River)

The Shawatlan drainage includes Woodworth Lake, Shawatlan River, Lake and Creek. Shawatlan Creek flows into Morse Basin at Fern Passage and supports significant populations of pink, coho and chinook salmon (5,000 to 25,000 escapement of pink and 1,000 to 5,000 escapement of coho and chinook), a major population of sockeye (5,000 to 25,000 escapement) and unknown numbers of anadromous steelhead, cutthroat trout and Dolly Varden.

Both pink and coho salmon utilize the lower Shawatlan Creek and estuary. The high valued chinook salmon (Oncorhynchus tshawytscha) spawns upstream of Shawatlan Lake in September. The fry emerge in spring and migrate directly downstream to the Lake, where they may stay for a year. The fish then outmigrate as smolts in June, to shallow coastal habitats for the summer before their seaward migration. The young smolts feed on herring, sand lance and other small fish or crustaceans. Adults return to spawning grounds after four or five years.

Sockeyes (Oncorhynchus nerka nerka) spawn throughout the length of Shawatlan River, above the lake from July to October. The newly hatched fry spend one year in Shawatlan Lake before migrating through coastal waters during the summer and then heading for the open ocean. Juveniles forage on a diversity of insects, copepods, crustacean larvae, euchalon, herring, tunicates and starry flounder. Adults return to spawn after four years.

Steelhead trout (Salmo gairdneri - an anadromous rainbow trout) may spawn in Shawatlan Creek and River during spring or fall. A two to three year rearing period takes place in the lake, before the marine phase begins. All fish may not migrate to sea. No surveys have been done to determine concentrations of steelhead in the Shawatlan system.

Cutthroat trout (Salmo clarki clarki) may also be anadromous, spending some of their life cycle in estuarine environments near their native stream mouth. Spawning occurs in spring. This species of trout is abundant in Shawatlan Lake, although numbers are unknown.

Dolly Varden (Salvelinus malma) like cutthroat, may have an anadromous phase after a three year rearing period in Shawatlan Lake. The marine part of the life cycle lasts two to three years, with adults returning to spawn in the creek and river in fall. Numbers of Dolly Varden in the Shawatlan System are unknown.

Federal Fisheries surveys have revealed coho in concentrations of from 200 to 1200. Sockeyes have been observed in concentrations of from 200 to 6,000 (6,000 were observed September 19th, 1982, a record for the drainage). Concentrations of pink salmon have not been determined since 1975.

Highest concentrations of sockeye and coho have been found in the kilometre below the power house on Shawatlan River and the segment .5 to 3 km above the lake.

Woodworth Lake is restricted to the presence of cutthroat trout since a dam has been constructed to provide the City of Prince Rupert with water. Some cutthroat spawning habitat occurs at creek mouths. Woodworth Lake and vicinity is designated as a watershed reserve.

Stumaun Creek

This creek has two forks which drain an area of 12 km^2, into Stumaun Bay, near Port Simpson. The east fork is steep, with no spawning gravel, although some rearing habitat is present below the water storage dam. The west fork, although draining a much smaller area, has moderate gradients and good gravel beds between frequent debris jams. Culvert washouts have created an obstacle to spawners. Also, logging road construction has diverted the stream in spots, and logging debris was responsible for the log jams in the past. The west fork supports significant populations of pink and coho salmon (5,000 to 25,000 pink escapement and 1,000 to 5,000 coho escapement), as well as unknown quantities of Dolly Varden, cutthroat and steelhead trout.

Intertidal areas in the estuary contain good gravel beds which may be used for spawning by pink and coho salmon when appropriate salinities prevail (Hinton et al, 1975).

Stumaun Bay contains large eelgrass beds which are valuable for herring spawning and salmon rearing.

Federal Fisheries surveys have revealed from 2,000 to 11,000 pink salmon in the first 1.5 km of the west fork of Stumaun Creek, during a single day survey. Abundances of coho fry have also been observed, although few coho spawners have been seen.

Several hundred spawning pink salmon were observed at Stumaun Creek (west fork) near the logging road crossing during the Sept. 17 and 18 field reconnaissance.

Lahon Creek

Lahon Creek flows into Pearl Harbour, on the west side of the Tsimpsean Peninsula, north of Big Bay. The creek drains approximately 17 km^2 between Georgetown Lake and Stumaun Creek.

The creek supports a major run of pink salmon (>25,000 escapement) and a significant run of coho (1,000 to 5,000 escapement), in the area between the 3 km mark and a high waterfall, 800 m north of the logging road crossing. Good runs of steelhead and cutthroat also exist in this area, although numbers have not been documented.

Much of Lahon Creek is paralleled by a logging road, which has severely damaged gravel beds through bank failures, erosion, and culvert washouts. Some rehabilitation has occurred since road construction.

Federal Fisheries surveys have shown a range of from 200 to 18,000 spawning pink salmon in Lahon Creek during single day surveys.

Several hundred pinks and approximately 20 coho were observed at the logging road where it crosses Lahon Creek during the September 17 and 18 field reconnaissance. An aerial survey revealed an even concentration of several thousand salmon in the spawning area described above.

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Kloiya Bay

Although the Kloiya River drainage lies to the south of the proposed corridor area boundaries, the bay and estuary are worthy of consideration. B.C. Fish and Wildlife (M. Whately, pers. comm.) considers the Kloiya drainage to be the most important steelhead spawning stream in the Prince Rupert area. The river also supports significant runs of coho salmon.

A Salmonid Enhancement Project study of the drainage has revealed that rearing habitat is being used to carrying capacity, and that any increase in production of coho salmon would necessitate the use of artificial or semi-natural rearing habitat, which would require modification of the stream channels, (Tredger, 1981).

Federal Fisheries estimates of escapement of coho and steelhead from the drainage are 500 and 125 respectively.

Prince Rupert Harbour

Prince Rupert Harbour and Tuck Inlet are used as juvenile rearing areas for all species of anadromous fish previously mentioned. The most important rearing areas are in protected bays with small creeks flowing into them.

The head of Tuck Inlet has been documented as a significant rearing area for salmon, although log booming may have diminished its importance.

No records of rearing fish populations are available for the harbour or inlet, although it can be assumed to be the combined total of escapements from all bordering streams.

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3.5.4 Assessment

Impact possibilities have been summarized in Table 3-12. Along with these general impacts, some site specific problems are noted below.

Both Stumaun and Lahon Creeks have been disturbed by prior logging road construction, although stream habitats are now regenerating. These two areas are considered to have moderate to high sensitivity to further impacts.

Silver Creek has a high potential for impacts, due to the unstable steep valley sides near its mouth.

Denise Creek has less potential for impacts, since an adequate width of level ground exists on the north side of the estuary and creek to reduce the chances of spawning beds being covered by debris from sliding and slumping.

The Shawatlan drainage has experienced a record sockeye run this year, and may continue to be important for this highly prized fish. If the transmission line crossed lower Shawatlan Creek, it would do so at a right angle, and would therefore not affect a large area.

The Woodworth Lake corridor segment would have an alignment which would parallel one tributary to the southwest of the lake. This area would have low potential for siltation problems.

If the transmission line were to cross Kloiya Bay to the east of the Rupert Substation, it would do so in a single span which would not affect fish populations or rearing habitat.

Little Georgetown Creek could be paralleled by the transmission line. This would constitute a low potential for impacts since the terrain adjacent to the creek is not steep.

Table 3-7. Possible Impacts to Fish and Habitats

POSSIBLE IMPACT	LOCATIONS
Siltation of spawning gravel beds from mass movement, dumping of sidecast and erosion due to construction road placement on steep terrain adjacent to fish habitat.	Silver Creek All other important stream locations where paralleling or crossing occurs. Denise, Georgetown, Lahon, Stumaun, Shawatlan, and one unnamed creek flowing into Woodworth lake, as well as Tuck Inlet and Georgetown lake shorelines.
Disturbance and removal of spawning gravel due to stream crossing with heavy equipment.	Silver, Shawatlan and Stumaun Creeks All other important stream locations where paralleling or crossing occurs.
Denudation of creek bank vegetation which moderates temperature in hot periods, increasing fry survival.	All important stream locations where paralleling or crossing occurs.
Blockage of the stream channel restricting fish migration, due to construction induced bank slumping and log debris.	All important stream locations where paralleling or crossing occurs.

Continued ...

Table 3-7. Possible Impacts to Fish and Habitats (Continued)

POSSIBLE IMPACT	LOCATIONS
Acidification of creek water by disturbing adjacent bog organic soils (highly acid). This problem can be accentuated by the presence of humic (as opposed to fibric) organic soil.	Stumaun, Georgetown, Shawatlan and Denise Creeks.
Pollution of streamwater from domestic sewage at construction camps, leaked fuels and herbicides.	All important stream locations where paralleling or crossing occurs.
General siltation of spawning gravel beds from upstream construction (roads).	All important stream locations where paralleling and crossing occurs.
Direct disturbance to spawning fish through human presence.	All important stream locations where paralleling and crossing occurs.
Overfishing, poaching and harrassment of spawning fish by the public.	All important stream locations served by powerline maintenance roads.
Post construction damage to spawning or rearing habitat due to unforeseen slumpage of streambanks, landslides, etc.	All important stream locations where paralleling and crossing occurs.

General concern has been expressed by Fish and Wildlife and Federal Fisheries personnel for the dumping of sidecast in lake and ocean shore areas where construction roads are placed parallel to them. This is most important in shallows where small streams flow in, as these are prime rearing areas for salmon. If backhoe construction techniques were used to minimize this problem, all shore areas would have minimal potential for impacts. This applies to Morse Basin, Prince Rupert Harbour, Tuck Inlet, Work Channel, and Georgetown Lake.

Although fish species abundances and diversity have not been documented for Neaxtoalk Lake, it is known that some fish do utilize the tidally influenced lake, as nets were observed in the water and on shore. An opportunity exists with either alignment (Georgetown Lake-Port Simpson or Work Channel), to avoid spanning the lake. If it was spanned, however, impacts on fish would be negligible as long as structures were located 50 m from shore.

Potential impacts have been designated by area on Map 4.

3.6 WILDLIFE

3.6.1 Methods

Wildlife groups of regional economic importance including ungulates, waterfowl and furbearers were emphasized in the study. Bears, upland birds, wolves and raptors were also considered and assessed for possible impacts. Additional wildlife species occurring on the Tsimpsean Peninsula were noted. Wildlife interactions with ecological factors such as climate, topography and other animals were also considered.

Information concerning each species' habitat utilization and estimated populations in the proposed transmission line corridor areas was collected and reviewed. This included several environmental studies completed as part of the Prince Rupert LNG bulk loading facility proposal (Hinton et al 1975: NEAT, 1975 and DOME, 1981) plus map references (Hatter 1977, BCFS 1:20,000 forest cover maps, CLI ungulate and CLI waterfowl land capability maps). Air photos were used to further refine and verify CLI land capability units.

Personal interviews and telephone conversations with B.C. Fish and Wildlife Branch staff provided information on government concerns for local wildlife habitats, populations, hunting and trapping statistics, potential impacts and possible mitigation procedures.

Trapping records and hunter sample statistics for Management Unit (M.U.) 6-14 of Region 6 (Skeena) were provided by the Fish and Wildlife Branch.

A two-day helicopter reconnaissance (September 17 and 18) of the proposed transmission line corridors and surrounding areas was made. Ground checks were made in a number of locations which were representative of the range of habitats utilized by major wildlife species. Particular attention was paid to areas of possible high impacts. Observations of animal tracks, feces and evidence of feeding were noted.

Species occurring in abundance, and of regional significance such as deer and waterfowl were emphasized, although an attempt was made to include all known species. Habitats of major species were subjectively ranked in importance based on previous studies and consultations with Fish and Wildlife personnel. Habitats rated as important or critical for a species' survival were then mapped and assessed for possible impacts. A range of feasible mitigation procedures were considered for these habitats. Final 'potential impact' ratings of 'low', 'moderate' and 'high' were then assigned to the species-habitat combinations. Definitions of these impact ratings are provided in Table 3-18.

Positive impacts were treated in narrative comments specific to the species and habitats in question. This was thought to be sufficient, as positive impacts were restricted to deer habitats of minor importance.

Gaps in existing data were identified, and recommendations were made for further study.

3.6.2 Inventory

Data has been organized for presentation by species, and for general and site specific cases.

Coast Black-Tail Deer

Two sub-species of black-tail deer (*Odocoileus hemionus*) share their southern (*sitkensis*) and northern (*columbianus*) range boundaries on or near the Tsimpsean Peninsula. This intergradation has been approximated at 52° N latitude (Cowan and Guiget, 1973). Coastal forests are the major habitat utilized by these deer on the Tsimpsean Peninsula.

Factors limiting the densities of *O. hemionus* include availability of relatively snow free winter range and the occurrence of wolf predation. Winter range is most critical. The deer require dense canopied areas for protection from extremes of temperature and heavy snow accumulations.

Table 3-8. Definitions of Impact Ratings for Wildlife

Impact Potential	Definition
High	Effects of the development having very severe consequences for wildlife habitat and/or populations would qualify for this rating. This category is reserved for only the most severe cases, such as modification of wildlife habitat with no limitations for major species production. This rating would correspond to impacts on lands of CLI classes 1, 1W and 2W. Also included would be irreparable or long lasting damage to wildlife populations or habitats of CLI classes 2 and 3, as well as damage to endangered species or their habitats.
Moderate	This category encompasses modifications to habitat and/or major wildlife populations designated as having 'very slight to slight limitations' for production (CLI capability classes 2 and 3). If wildlife species of lesser importance may be severely affected, then the appropriate habitats would be rated in this category. Also included would be populations and/or habitats with high potential for impacts (as above) but positively influenced by beneficial mitigating actions.
Low	This category includes modifications to habitat and/or major wildlife populations designated as having 'slight' limitations for production (CLI classes 4, 5 and 6). Also included would be minor populations and/or habitats moderately affected or major populations and/or habitats moderately affected, but positively influenced by beneficial mitigating actions.
None	Habitats or population modifications would be negligible - not measurable.

Continued/2

Table 3-8. Definitions of Impact Ratings for Wildlife (Continued)

Abbreviated explanation for CLI capability ratings for waterfowl and ungulates.

CLI Land Capability Classes	Explanation
1	No significant limitations to production (not present along corridors).
2	Very slight limitations to production.
2W	Winter range for ungulates.
3	Slight limitations to production.
3W & 3M	Winter range for ungulates and migration stopover for waterfowl.
4	Moderate limitations to production.
5	Moderately severe limitations to production.
6	Severe limitations to production.
7	Limitations so severe that there is no or very little production.

An excellent food source is provided by coastal fringe habitats benefitting from the moderating effects of the ocean. The adjacent growth forests containing arboreal lichens and sparse shrub cover provide cover and protection from adverse weather.

The deer population of the Tsimpsean Peninsula is low (1 per mi^2 as estimated by Hinton et al, 1975), due mainly to two factors:

1) intermittent and variable snowdepth: In general, starvation due to heavy snow accumulations (greater than 45 cm) accounts for 80% of winter mortality. Over one half of this total is accounted for by fawns (Klein, 1979). Also, the quantity and quality of winter range is important in determining the extent of winter mortality. This limitation is most difficult to quantify, as acute food shortages in the winter vary over short time periods (from week to week), depending on snow accumulation and melt. Deep snow for a short duration has less effect than moderate depth for a long period. Timing of spring 'greenup' is also important. No evidence of winter range overgrazing has been found in the Tsimpsean Peninsula area, however, little effort has been made in this regard.

2) wolf predation: Klein (1965) found that wolf predation was responsible for preventing overgrazing of range on an insular Sitka deer population. This population check can be beneficial if the population is large and healthy, or a detriment when combined with other severe mortality factors such as disease, parasitism and poor forage growth and availability.

Generally, the deer seek new growth of herbs and shrubs by following the advance of spring over a range of elevations. As spring approaches, steep south-facing coastal slopes are the first to green up, followed by estuary and riparian areas. In summer and fall, early successional stage areas provide a diversity of plant food species which are high in protein and nitrogen.

As winter progresses, the deer tend to congregate along the coastal fringe, and uitilize the estuarine or salt marsh areas as food sources. The foreshore area may, in some years, become the last available source of food, with the deer making extensive use of the intertidal zone vegetation, until the return of the spring green up period.

Almost all of the Tsimpsean Peninsula has been rated as Canada Land Inventory (CLI) capability class 6, (for deer only) with the remaining few coastal winter range areas listed as class 5. This represents moderately severe to severe limitations for deer populations, in the form of poor forage growth. The limitation is contributed to by three factors:

shallow soil
heavy rain and heavy intermittent snowfalls
saturated soil

B.C. Forest Service forest cover maps containing 'critical wildlife habitat' (EW1), and 'major habitat' (EW2) ratings show no critical or major habitats for the entire peninsula.

Table 3-9 lists vegetation units extracted from NEAT(1975), and summarizes the contributions each unit makes to the food and shelter requirements of the local deer population. It should be noted that although the first two vegetation units listed are confined to a narrow coastal strip, they constitute the critical habitats (winter range) on the peninsula.

During the field reconnaissance of Sept. 17 and 18, a number of locations were observed to have sustained heavy deer use. These are summarized in Table 3-10 and shown on the wildlife map (Map 4).

The observations in Table 3-10 do not reflect a complete reconnaissance of deer habitat or population distribution for the Tsimpsean Peninsula. At best, these observations serve to corroborate opinions based on

Table 3-9. Black-tail deer habitats found within proposed transmission line corridors on the Tsimpsean Peninsula.

Vegetation Units	Forage Species*	Comments (Habitat significance)
1. Tidal marsh	Rockweed Bentgrass Pacific brome Hairgrass Red fescue Holy grass Sea barley Bluegrass Alkali grass Sea arrowgrass Sedges Deer cabbage Red alder Salal False axalea Blueberry & Huckleberry Bluejoint	Critical coastal habitat during periods of heavy snow and cold temperatures, and first 'greenup' of spring.
2. Spruce-Alluvial forest (coastal & streamside)	Arboreal lichens Deer fern Vaccinium spp.	High dense canopy provides thermal shelter and reduces snow cover - sparse understory remains accessible for forage.
3. Cedar-Hemlock forest	Lichens Dogwood Sedge Skunk cabbage False Lily-of-the-Valley	Extensive forest cover provides some summer forage.

Continued/2

Table 3-9. Black-tail deer habitats found within proposed transmission line corridors on the Tsimpsean Peninsula. (Continued)

Vegetation Units	Forage Species*	Comments (Habitat significance)
	Siberian miner's lettuce Foamflower Bracken fern Calamagrostis canadensis Mannagrass Galtheria shallon Vaccinium spp. Western red cedar Western hemlock-windthrown tops	
4. Bog and Bog-forest	Marsh marigold Goldthread Fauria crista-galli Gramineae - ex. Agrostis aequivalvis Carex spp. Berberis spp. Galtheria shallon Vaccinium spp.	Extensive bog areas provide summer range - raised bog terraces are wind scoured in winter, exposing some forage.

* All forage species listed have been extracted from NEAT (1975) and Dome (1981).

Table 3-10. High deer use areas of the Tsimpsean Peninsula: based on an aerial and ground reconnaissance (Sept. 17 & 18, 1982).

Corridor Segment & Locations	Observations
1. Denise Inlet - Woodworth Lake	
Denise Creek estuary	Good winter range - flood terraces on the N side of the creek contained sparse grass cover. Tidal marsh areas on both sides of the river mouth possessed extensive tall grass areas which would be subject to early spring growth. Deer tracks and bedding sites were observed here.
Bannock Lake	A concentration of deer tracks were found in a raised bog approximately 150m SW of Bannock Lake outflow. No other tracks were found near the lake.
2. Shawatlan Lake	
Shawatlan estuary	Good winter range. This tidal marsh and estuary provides good summer grass cover which would be subject to early spring growth.
3. Laurier Cove	
Silver Creek	Riparian habitat with some tall spruce and thick cover of shrub forage species is present. Some steep south facing terrain also promotes an early spring thaw and 'green-up'. There is also adequate escape terrain upstream.

Continued/2

Table 3-10. High deer use areas of the Tsimpsean Peninsula: based on an aerial and ground reconnaissance (Sept. 17 & 18, 1982). (Continued)

Corridor Segment & Locations	Observations
4. Tuck Inlet, East Side	
Raised bog on benches	Well worn game trails were present although no evidence of browsing could be found.
5. Work Channel to Tuck Inlet	
Little Georgetown Cr. to map point 'G'	Mature Cedar-Hemlock - logging slash edge areas were subject to some browsing. In addition, this area had a moderately high amount of arboreal lichens associated with mature forest canopy.
Ridge crest 1 km S. of map point 'H'	This raised bog had a high concentration of tracks, but no evidence of browsing. The exposed nature of the ridge would allow winter snows to blow off, exposing food.
6. Georgetown Lake - Port Simpson	
Lahon Creek & Stumaun Creek	Logged areas contained deer tracks, indicating their presence. Stumaun Creek estuary had good spruce-hemlock stands and transition zone (intertidal) shrubs for winter range. This latter area has been designated as high value deer habitat (NEAT 1975).
Neaxtoalk Lake	Game trails and tracks demonstrated that this is a 'high use' deer area. Some coastal spruce-hemlock stands close by provide good winter range, and fresh water marsh grasses at the lake would be subject to 'green-up' in early spring.

previous studies, and to make generalizations as to which major habitat types are receiving use.

Tidal marshes, estuaries and riparian areas are important food sources (in the fall and winter at least). "Cut over" areas in early stages of regeneration are also utilized. Some bog and bog-forest communities receive use while others do not. Those bogs which are favored may also provide good access between adjacent climax forests and/or shoreline habitats (well defined trails were noted at raised bog sites on the east shore of Tuck Inlet and Bannock Lake).

Coastal Spruce-Alluvial fringes were not adequately surveyed to give a relative indication of deer use. Food in the form of arboreal lichens was found there however. A logged area adjacent to the coastal fringe at Stumaun Creek was used.

No evidence of heavy grazing was observed anywhere on the peninsula. The deer population is likely small and dispersed enough to maintain a low probability of any forage shortages. This opinion was supported in discussions with B.C. Fish and Wildlife staff (A. Ackerman - previous District Conservation Officer and A. Edie - Regional Habitat Biologist). It would be advantageous however, to survey coastal fringe habitats in winter, when the deer have concentrated on the coast, to determine utilization during the critical period of food availability.

Hunter sample statistics for all big game species common to the Tsimpsean Peninsula were obtained from B.C. Fish and Wildlife mailback questionnaire summaries (Table 3-11). The 'reported' black-tail deer harvest for the entire Skeena Region averaged 167 for the period of 1976 to 1979. After correcting for 'non-response', it was estimated that 1574 deer were shot on average for the same period. Management Unit, (M.U.) 6-14 accounted for less than one percent of the 'reported' and 'estimated' average deer harvest. Of all the responses tabulated from MU 6-14 for the four year period, only one kill location (Shawatlan Lake) was within the current study area. This single occurrence did, however,

Table 3-11. Reported and Estimated Hunter Bag Statistics for Selected Species in Management Unit 6-14.
(From B.C. Fish & Wildlife Mail-Back Questionnaire)

SPECIES	REPORTED (ESTIMATED) BAG						
	1976	1977	1978	1979	Average	Regional Average	Records for the Tsimpsean Peninsula (Kill Location)
Coast Black-tail Deer (*Odocoileus hemionus*)	1(4)	0(0)	2(14)	0(	1(5)	167(1574)	1 deer shot at Shawatlan Lake in 1978.
Black Bear (*Ursus americanus*	10(36)	4(22)	4(12)	8(27)	7(24)	95(342)	1 black bear shot at Silver Creek in 1979.
Wolf (*Canis lupus*)	3(41)	0(0)	0(0)	0(0)	0(0)	17(143)	1 wolf shot on the Tsimpsean peninsula in 1976.
Ducks & Geese	27(375)	39(383)	165(1120)	100(931)	83(702)	3228(8013)	No records available.
Upland Birds	21(283)	3(29)	57(396)	18(136)	25(211)	7078(28,054)	No records available.

represent half of the reported kills for the MU in 1978. Deer hunting is usually permitted for a one month period, ending in the last week of October. Most of the hunting activity takes place along the coast using boat access.

Since the Tsimpsean Peninsula comprises only about 5% of MU 6-14 (DOME, 1981) and since hunter questionnaire responses are highly variable, some caution should be used in interpreting these results. However, on average the Tsimpsean Peninsula black-tail deer harvest is insignificant with respect to the entire Skeena Region, but may contribute up to half of the albeit small harvest for MU 6-14.

Native hunting has not been documented. This may represent a significant contribution to the deer harvest, as two villages (Metlakatla and Port Simpson) are situated on the peninsula.

Ducks and Geese

Up to 22 species of ducks, four species of geese and two swan species have been documented as migrants, winter residents and breeders in areas adjacent to and surrounding the proposed LNG terminal site (DOME, 1981). Breeding waterfowl include Canada geese (Branta canadensis), mallards (Anas platyrhynchos), common merganser (Mergus merganser) and American green-winged teal (Anas crecca carolinensis).

Most significant of the migrating and winter resident waterfowl to frequent the current study area include scoters (white-winged, Melanitta deglandi, surf - M. histrionicus and common - M. niger), oldsquaw (Clangula hyemalis), black brant geese (Branton bernicla) and Canada geese. (Martin, 1978).

Several other large water related bird species are also common to the peninsula. Breeders include sandhill cranes (Grus canadensis), and pelagic cormorants (Palacrocorax pelagicus) red-throated loons (Gavia stallata) and great Blue herons (Ardea herodias). Non-breeders include

two additional species of loon (arctic - G. arctica and yellow billed - G. adamsii) and three grebes (western - Aechmophorus occidentalis, red necked - Podiceps grisegno and horned - P. auritus) (NEAT, 1975).

The best waterfowl habitat on the Tsimpsean peninsula is at Big Bay and Pearl Harbor, where up to 500 resident geese have been counted (DOME, 1981). These two locations are on the western side, and are out of the study area. Second in importance to these locations would be the Salt Lake Provincial Park area, across Prince Rupert Harbour from the city. This tidal marsh is also out of the current study area boundaries.

Four habitat types are utilized by waterfowl within the study area:

1. Protected tidal marsh - These marshes are primarily used by migrants, and are limited in extent due to predominantly steep shorelines. Some Canada goose and mallard nesting may take place. The head of Tuck Inlet has been described as a unique Salt marsh habitat (NEAT, 1975), although its current value as nesting habitat may be lessened by log booming in the area. Stumaun Bay, east of the creek estuary, and Zumtela Bay have small areas of tidal marsh, while extensive marsh occurs .5 km S.W. of Shawatlan Lake (Morse Basin).

2. Tidal estuary - Locations where creek outwash material has been deposited in and above intertidal areas appear to have good nesting cover for Canada geese, mallards and teal. Examples of this breeding habitat include Denise Creek, Silver Creek and Stumaun Creek estuaries. Denise Creek is the largest in aerial extent of the three. Martin (1978) rated Stumaun estuary as having high potential for

dabblers and Stumaun Bay as good diving and sea duck habitat.

3. Open bog - This extensive habitat is favored for breeding by sandhill cranes and red throated loons. Canada geese will also nest in these areas.

4. Inland lakes - More than 14 lakes (seven of which are named) contain some waterfowl nesting habitat. Georgetown, Little Georgetown, Shawatlan and Woodworth are larger lakes with marsh areas at points of creek inflow. Georgetown Lake has the best nesting cover in the form of a well vegetated gravel spit protruding into the lake at the inflow of Little Georgetown Creek. Neaxtoalk, Mahlon and Bannock Lakes, although small, contain extensive areas of emergent plant growth (rushes - Scirpus and sedges) and gently sloping upland areas with some degree of bog and bog-forest development. Martin (1978) rated Neaxtoalk Lake as having moderately high potential ('2' on a 1-5 scale) for dabbling duck production.

Of these four habitats, the first two, which are adjacent to salt water, should contain the most invertebrates and submergent plants. Fresh water habitats are extremely acid in this area, due to bog conditions, and are therefore poor in aquatic food sources. All four of the nesting waterfowl species found in this area eat primarily sedge and rush seeds, leaves and stems of subaquatics (eelgrass) and green grass and forb shoots, which are most prevalent in spring. Eelgrass is especially abundant in Stumaun Bay.

Hatter (1977) mapped waterfowl abundance ranges for the study area in the following manner:

Stumaun Bay - fall migrating geese	:	101 to 500
wintering diving ducks	:	6 to 50
spring migrating diving ducks:		> 1,000
wintering and resident diving birds (loons, grebes, cormorants):		1 to 5
Denise Inlet -wintering swans	:	5 to 50
wintering Puddle ducks	:	101 to 500
wintering diving ducks	:	501 to 1,000

All other locations - no appreciable numbers of waterfowl.
The entire study area has waterfowl habitat limitations (CLI). Most locations were designated as capability classes 6 and 7, which correspond to severe limitations for waterfowl. The only exception to this was Stumaun Bay, which was classified as 3M - of importance as a migration stopover.

Waterfowl resource values for the study area are concentrated primarily in the Stumaun Bay and Denise Creek Inlet. Neaxtoalk Lake should be added to these areas as it offers good protection from adverse weather, has abundant emergent growth for brood rearing and predator evasion and is close to Stumaun Bay, which would enhance its value as a 'wintering' area. Also, swans (NEAT, 1975), mallards and white-winged scoters (this study) have been observed on the lake.

Waterfowl sitings during the September 17 and 18 field trip were made at Neaxtoalk Lake (2 pairs each of mallards and scoters) and Denise Inlet (12 mallards). No other ducks or geese were sited in eight hours of helicopter time. An October 19 overflight revealed several hundred geese and ducks in the Morse Basin and Denise Inlet areas.

B.C. Fish and Wildlife hunter sample data for 1976 through 1979 (Table 3-11) has been recorded on a Management Unit basis (6-14), of

which the study area comprises approximately five percent. This cannot be broken down further as kill locations were not given. Thus, the value of the information is limited.

Average combined duck and goose harvests reported for MU 6-14 and the entire Skeena Region for the sample period were 83 and 3228 respectively. Similarly, average estimated harvests were 702 and 8013. These harvest estimates may reflect a disproportionately high contribution of the MU to the regional harvest total, since almost 9% of the regional harvest took place on 3% of the number of Management Units.

Upland Gamebirds

Three species of grouse are common to the study area. These are blue (Dendragapus obscurus), spruce (Canachites canadensis) and ruffed grouse (Bonasa umbellus) (NEAT, 1975). The blue grouse prefers burned-over areas and edge vegetation in coastal rainforest, while the spruce grouse prefers edges in deep forest areas. Ruffed grouse, on the other hand, is most common in deciduous forest areas, but is known to frequent edges within coniferous forest zones.

It was estimated in the NEAT (1975) report that close to 100 upland birds are harvested on the Tsimpsean Peninsula yearly. When hunter sampling statistics are compared with this number (an estimated average of 211 harvested per year for the entire Management Unit), it appears to be a liberal estimate. Nonetheless, this estimated total for the MU (211) is insignificant when compared with the Skeena Region yearly estimated harvest of 28,000. In fact, it represents less than 1% of the total.

Furbearers

The most common furbearing animals on the Tsimpsean Peninsula are Coastal mink (Mustela vison) and marten (Martes americana). Mink is most common in the vicinity of Port Simpson while martens inhabit boggy areas of Cedar-Hemlock forests (Banfield, 1974). Additional species significant

to trappers on the Peninsula include beaver (Castor canadensis) river otter (Lutka canadensis), wolverine (Gulo luscus), short-tailed weasel (Mustela erminea), muskrat (Odonatra zibethica), red squirrel (Tamiasciurus hudsonicus) and red fox (Vulpes fulva).

Although the Indians of the Tsimpsean Peninsula do not register their harvests, trapline records have provided relative indications of furbearer abundances (Table 3-11) and trapline areas prone to impacts.

Birds

Over 85 species of birds are common to the Tsimpsean Peninsula and surrounding environs. In addition to those species already mentioned, this includes 20 passerines, 11 shorebirds, 7 gulls, a hawk, owl and osprey. A more complete treatment of local habitats and populations is given in NEAT (1975) and DOME (1981).

Coastal and marine habitats contain the greatest abundance and diversity of bird species. As with the previously mentioned waterfowl species, the Big Bay and Pearl Harbor areas appear to be the most important habitats on a local scale (DOME, 1981).

Black Bear

Black bears (Ursus americanus) are common on the Tsimpsean Peninsula. The subspecies kermodei occurs over the extent of the north coast (Banfield, 1974), although records of sightings on the Tsimpsean Peninsula could not be found. Two of its color phases (white and blue) are protected in Region #6. Approximately 400 bears may inhabit the Tsimpsean Peninsula (NEAT, 1975).

All vegetation types in the study area are frequented by bears. Berry producing shrubs in clearcuts, forest-bog fringes and riparian zones have widespread occurrence and are of high importance. Coastal muskeg areas are also of high importance due to their lush growth.

During periods when salmon spawning occurs, bears tend to congregate along streambanks and estuaries.

No detailed habitat or population data has been collected previously in the study area or in northwestern B.C. as a whole (DOME, 1981). As a result, it is not possible to relate the commonness of the black bear on the Tsimpsean Peninsula to populations of the management unit as a whole, or the Region.

Signs of black bear presence were noted at two locations during the fall 1982 field reconnaissance. These were Silver Creek (.5 km upstream from the estuary) and Stumaun Creek logging road (west of the creek outflow).

There are two seasons for black bear hunting in MU 6-14. The fall season commences at the beginning of September and ends in mid November, while the spring season includes all of April and May.

Harvest records for this species (Table 3-16) show that over a four year period (1975 to 1979), between four and ten kills were reported for MU 6-14. Only one of these was verified to be within the study area (Silver Creek, 1979). When hunter sample statistics were adjusted to account for non-response, it was estimated that an average of 24 black bears are harvested annually in the MU. This represents 7% of the estimated 342 total for the Skeena Region.

It is evident from these statistics that black bear harvests in MU 6-14 are above average when viewed from a regional perspective. MU 6-14 makes up only 4% of the Region by area. Further, the bear taken at Silver Creek in 1979 was one of eight reported for the M.U., indicating some value of the study area for bear hunting.

Wolf

Wolves (Canis lupus) occur throughout coastal British Columbia. Habitat preferences are based mainly on the occurrence and numbers of big game prey species such as deer.

According to the NEAT report (1975) the wolf population of the Tsimpsean Peninsula is supported mainly by animals living in the coast littoral zone. This would include upland birds (grouse) ducks, shrews, mice, voles, squirrels, wood rats, marten, short-tailed weasel, and black-tail deer as the main component of their diet.

Wolf predation was cited as the single most important factor in staving off black-tail deer over-population in insular populations of the Alaska Panhandle (Klein, 1965). In turn, wolf populations are kept in check by starvation, disease (distemper, mange) and parasites. Since the deer population of the study area is known to be low, it stands to reason that wolf numbers are also kept at a minimum.

Wolf tracks were observed at two locations during the field reconnaissance. They were the ridge (raised bog and forest) between Little Georgetown Lake and Work Channel, and .5 km up Silver Creek.

According to B.C. Fish and Wildlife hunter sample statistics, an average of 17 wolf kills per year are reported for the Skeena Region, with one (or less) originating from MU 6-14. Of the four years of survey data analyzed (1976 to 1979), only a single wolf was reported shot in the study area (Tsimpsean Peninsula).

Other Animals

Rare Species

Two rare bird species occur in the vicinity of Tsimpsean Peninsula. Peregrine falcons (Falco peregrinus) are known to nest in the Chatham Sound area. Three active eyries were reported by NEAT (1975), although none have been reported for the current study area. Bald eagles (Haliaeetus leucocephalus) on the other hand, although endangered on a

continental scale, are numerous in fall and winter on the Alaskan and Northern B.C. coast. Up to 21 eagles have been observed in the Port Simpson area (DOME, 1981). Several eagles were also spotted in the areas of Stumaun Bay, Neaxtoalk Lake, Work Channel - Little Georgetown Lake pass and Silver Creek during the Sept. 17 and 18 reconnaissance.

Sea otter (Enhydra lutris) populations were decimated by trappers at the turn of the century, but have successfully reestablished themselves since 1971, when they were reintroduced to the Aleutians (Banfield, 1974). Occasional sightings have occurred north of the Tsimpsean Peninsula, and their breeding range is moving south (Van Drimmelen, personal communication).

Big Game

Moose (Alces alces) and grizzly bears (Ursus arctos) occur on inlets along the coast of B.C. DOME (1981) has reported that these two species may be occasional visitors to the Tsimpsean Peninsula, although no authenticated sightings were mentioned. Mountain goats (Oreamnos americanus) are common east of Work Channel, and have been known to frequent shoreline areas during winter (D. Reynolds, pers. comm.). It is reasonably certain, however, that their range does not extend across the channel to the Tsimpsean Peninsula.

Others

The extensive Hemlock-Cedar forests of the Tsimpsean Peninsula support a multitude of small mammals, including two species of shrews, (Sorex cinereus and S. vagrans), four mice species (Peromyscus maniculatus, mus musculus domesticus, Zapus hudsonicus, Z. princeps), two species of voles (Clethrionomys gapperi, microtus longicaudus), lemmings (Synaptomys borealis), two squirrel species (Tamiascurus hudsonicus, Glaucomys sabrinus), three species of rat (Neotoma cinerea, Rattus norvegicus and R. rattus alexardcinus), two species of bats (Myotis lucifugus, Myatis californicus), and marmots (Marmota monax canadensis).

Amphibians and reptiles found in the study area include toads, salamanders and garter snakes (NEAT, 1975).

Groups of up to 100 shore birds were observed in Laurier Cove and Denise Inlet during the Sept. 17 and 18 field reconnaissance.

Traplines and Guiding Territories

Three traplines on the Tsimpsean Peninsula are currently registered with the Fish and Wildlife Branch in Smithers. They include:

1. Mahlon-Bannock Lakes, Tuck Inlet and Silver Creek Watershed south to Pethick Point.

2. Work Channel south to Silver Creek watershed.

3. Northern end of the peninsula south to Stumaun estuary.

Two other traplines are not in use at present:

1. Little Georgetown Lake and area.

2. Shawatlan and Woodworth Lakes.

Of the three active traplines, only one has harvest statistics filed. (The other two are native run, and are not required to report harvests). Average yearly harvests (1977 to 1981) included Marten (23), mink (10), otter (3), wolverine (1), weasel (1) and squirrel (4).

Documented harvest statistics do not represent production capacities or harvestable surpluses for the areas in question, since trapping and hunting efforts have been well below maximum possible levels.

The Tsimpsean Peninsula is part of a single hunting guide territory which has seen little use in the last few years. It is unlikely that any locations within the current study area are used for guiding purposes.

The importance of trapping to Port Simpson people is largely cultural and recreational. About one household in six has at least one member who traps. Most active traplines are along Work Channel and the Nass River.

Only the former is within the study area. Major species trapped include mink, marten and otter. A few beaver, muskrat, fishes, seals and lynx are also harvested.

Native Wildlife Utilization

All information concerning native wildlife utilization (hunting and trapping) was to be derived from DOME's liaison with the Port Simpson Resource Development Committee. A document containing this information was made available to TERA Environmental Consultants Ltd. after the submission of the first draft of this report (Read and Associates, 1982). Consequenty, only a brief summary of native hunting and trapping follows. Additional information can be obtained from the above mentioned document.

Returns from the household survey indicate that there are active hunters in approximately one third of all households (60 hunters). Deer are the most important hunted species followed by ducks and geese. Approximately 60 deer were shot in 1981. Most were from the Stumaun Creek logging road and Port Simpson Bay areas. Duck and goose hunting is restricted to Stumaun Bay and the Georgetown Lake/Big Bay area. This second location is not within the study area. The 1981 harvest has been estimated at several hundred ducks and geese.

3.6.3 Assessment

Direct wildlife disturbances will be caused by clearing of forested areas, construction of transmission lines and implementation of measures to control vegetation on the chosen transmission line right-of-way. Human presence and use of construction equipment causes stress, especially to calving ungulates and nesting waterfowl. Careless garbage disposal may upset feeding patterns of bears and increase the likelihood of human-bear interactions. Long term public road access to the right-of-way may result in changes to current hunting and trapping patterns.

Clearing of right-of-ways may remove food and shelter necessary for winter survival of ungulates in particular, and other animals in general. Selective herbicide application and hand clearing can increase browse and available winter range forage species. (Miller, 1982). Generally, brush suppression using broadcast herbicides and mowing techniques tends to eliminate ungulate browse species.

Snow depths on right-of-ways may be up to two times deeper than under a climax forest canopy. Because Sitka deer begin to have serious trouble moving and foraging at snow depths in excess of 45 cm this may constitute a severe impact, if the right-of-way has been cleared through or adjacent to prime winter range. (Klein, 1979). The yearly snowfall average for Prince Rupert is 113 cm (NEAT, 1975). High snow depths may be sustained in severe winters, even at sea level, where the most critical winter range occurs (Spruce-Hemlock and Riparian vegetation types).

Where newly constructed transmission lines parallel a creek, lake or ocean shoreline, sidecast from construction roads may destroy high quality forage in areas such as riparian or tidal marsh zones. These areas may be important as producers of subsistence food supplies during protracted periods of snow accumulation. This moderately severe impact could occur at Tuck Inlet, Little Georgetown Creek, Georgetown Lake and Work Channel.

Clearing of mature forest may create new habitats for wildlife species, thus altering distribution and density patterns not originally present or it may tend to greatly favour a few species over others. This would be greatly accentuated by the existence of differing regeneration times for different vegetation communities, such as coastal forest and sub-alpine bog forest. This impact is not considered serious for the study area.

The most important point to consider in predicting the overall effect of right-of-way clearing on deer habitat is the change in the relative abundances of each habitat type. If one habitat type is abundant and is not fully utilized by wildlife, then impacts will be negligible. This is the case with the extensive areas of CLI class 5 and 6 (ungulates) Cedar-Hemlock forest, found within all corridors. The case is also similar for class 5 'open bog' and 'bog forest communities'. Also, bog areas would be subject to minor modification as clearing would not be necessary. Structures should be placed on exposed bedrock wherever possible, minimizing spot clearing. Bog-forest edges just above open bogs would likely be used for construction and maintenance road placement because of better drainage. Since this habitat may be of some importance as winter range in exposed areas, it has been designated has having moderate potential for impacts.

The most impact sensitive deer habitats are spruce alluvial forest areas since they are at a premium, and are necessary for winter survival. These class 5 (CLI ungulate capability rating) areas have been designated as having moderate potential for impacts.

Intertidal marsh and estuary areas are important for both deer and waterfowl. The most important waterfowl wintering and migration stopover location (Stumaun tidal marsh and estuary) in the study area has been designated as CLI class 3M, and therefore would have moderate potential for impacts. Denise Creek and Silver Creek estuaries, although designated as class 5 ungulate and waterfowl habitat, would also qualify as having moderate potential for impacts.

3.7 LAND USE AND SETTLEMENT

3.7.1. Methodology

The land use and settlement overview assesses each of the alternative corridors linking the Rupert Substation south of Morse Basin with the proposed LNG development site. This review deals with the use of the land within the study area, and the potential areas for future development.

The information used to develop the land use reports was provided by planners working for local, regional, and provincial government agencies. Available reports, documents, and plans were reviewed and the study area was visited to determine the recent changes in land use. Aerial photographs and helicopter overflights were utilized to supplement information provided by government agencies.

The City of Prince Rupert established an official community plan in February of 1980, in which the goals and objectives for future development were clarified. The Skeena-Queen Charlotte Regional District has recently acquired a contractor (with the aid of other government agencies) to develop a growth management plan for the Prince Rupert subregion. Results of this study will not be available until January of 1983.

In addition, the Port Simpson Indian Band has recently contracted with a planning consultant to prepare a plan for the Indian Reserve on the Tsimpsean Peninsula. The draft of this plan will not be available for review until 1983. Currently, negotiations are underway between representatives of the Indian Band and Dome Petroleum to restore access for the transmission line, a road from Prince Rupert to Port Simpson, and the proposed gas pipeline. Band representatives have tentatively approved the transmission line on the Reserve within the designated

corridor, pending a review of the expected environmental impacts (M. Donnelly, pers. comm.).

Socioeconomic data for Port Simpson were not collected specifically for this report. Dome Petroleum and the Port Simpson Indian Band requested that direct contact with Port Simpson residents be avoided during negotiations (L. Arthurs, W. Austinstead, pers. comms.). Information was to be provided by a concurrent study of LNG project impacts being prepared for the Port Simpson Indian Band Council. However, the Council's study was received after the draft of the transmission line study was submitted. For a complete description of Port Simpson's socioeconomic features, the reader is referred to the "Impact Study, Western LNG Project, Volume 2, Socioeconomics and Resource Use", by Read Environmental and Planning Associates.

Planners and other individuals responsible for land use and development within the study area were interviewed with regard to potential conflicts generated by locating transmission lines within the alternative corridors. A complete list of contacts is presented in Appendix A.

3.7.2 Inventory

Much of the study area lies within undisturbed Crown land, with the largest parcels of alienated land belonging to the City of Prince Rupert and the Port Simpson Indian Band. There are few upland leases within the corridors under study. Within the Morse Basin East Corridor, five leased properties accommodate three recreation cabins on the shoreline of Morse Basin. An additional small upland lot is under lease near the mouth of Shawatlan Lake. The only private property located within the corridors is a large parcel (lot 444) owned by The City of Prince Rupert and forming the western boundary of the City's watershed reserve.

The corridors under study pass through five Indian Reserves between Kloiya Bay and Port Simpson. An unoccupied Indian Reserve No. 5 is

located on the western and eastern borders of Kloiya Bay. A 2.4 ha parcel has been set aside at Grassy Bay for the Wilnaskancaud Indian Reserve (Metlakatla Band). The Shoowahtlans Indian Reserve occupies 0.6 ha at the west end of Shawatlan Lake. The McKenna-McBride Commission removed 6.9 ha from this reserve in 1916. The Metlakatla Band is pursuing the cut-off issue with the Provincial Government. A second small (1.8 ha) parcel of the Metlakatla Band is located at the head of Tuck Inlet.

The largest reserve within the study area comprises a total of 13,650 ha. Indian Reserve No. 2 on the Tsimpsean Peninsula is equally divided between the Port Simpson Band (northern half) and the Metlakatla Band (southern half). Present land use on the northern half of the Tsimpsean Reserve is limited to the coastal areas, mostly at the Village of Port Simpson. The village has about 1,000 residents; most are members of the Port Simpson Indian Band. The economy of the community is closely tied to the north coast commercial fisheries. Transportation to the village is provided by charter and scheduled air carriers and boat passage. No overland vehicular route from Prince Rupert to Port Simpson currently exists.

One additional large scale land use restriction is worth noting. A Greenbelt Reserve (0325397) protects most of the slopes of Mount Morse above an elevation of 152 m (500 feet).

The Prince Rupert study area is sparsely settled in general, with five community centres accommodating a large percentage of the area's residents: Port Simpson, Metlakata, Prince Rupert, Norwegian Village, and Port Edward. The City of Prince Rupert is the largest community, holding 88 % of the total subregional population. The municipal boundaries of Prince Rupert encompass Kaien Island and extend south to include Ridley Island.

Incorporated in 1910, Prince Rupert is the third largest natural ice-free habour in Canada, receiving freighters, cruise ships and ferries from many parts of the world. Fishing is the most important element of Prince Rupert's economy in terms of employment, athough the future economic potential may depend on port expansion. The quest to expand port capacity will be a factor in determing the direction of future growth. The industrial property at Hospital Cove is owned and managed by British Columbia Development Corporation. The city has zoned the area between Highway 16 and the shoreline at Hospital Cove special industrial uses, including construction camps and accessory structures.

Residential land use within Prince Rupert has been limited by terrain constraints to the northern part of Kaien Island. The city has expressed concern for the housing needs of future residents, noting the constraints that soils and topography of the area place on land development. Population forecasters predict that the city's 1981 population of 16,195 will increase to 19,100 by the end of the decade. Yet, Prince Rupert has little land remaining for new residential construction. To meet the short term needs, the city has encouraged infilling at 12 locations within the city, mostly in the northeast sector near Seal Cove. Other parcels at the base of Mount Oldfield may also be developed in the near future.

The land north of Oliver Lake Park to the vicinity of Butze Point is also being considered for residential use. The Prince Rupert Community Plan calls for eventual development of low-to-medium density housing in this area, with sufficient park space, school sites, and waterfront access to provide for the needs of future residents. Currently the area between Highway 16 and Morse Basin in virtually untouched. A single private residence sits on a 10 m bluff above the highway on the east side of Yellowhead 16, about 1/4 km north of the Galloway Rapids Bridge.

To meet the long term residential needs, City Officials are considering development south along Morse Basin, west to Digby Island, north to the opposite shore of Prince Rupert Harbour, or east across Fern Passage to the mainland. There are problems with all alternatives and no firm policy yet exists for long term city expansion. The aforementioned regional growth management plan is expected to provide guidance on this issue when it is completed in early 1983.

Recreation and open space uses also exist within the Morse Basin West Corridor. A viewpoint of Butze Rapids is provided for motorists on the old Highway 16 north of Butze Point. South of the Point, a dilapidated wooden foot path provides an inconvenient means of waterfront access from the highway to the shoreline of Morse Basin.

Oliver Lake Provincal Park is located on the west side of Highway 16 within a zoned Amenity-1 area, which includes most of Kaien Island. Amenity-1 zoning allows open space uses such as a golf course, ski course, log sorting, and quarrying. The Prince Rupert Gun Club is situated across the highway from Oliver Lake. A small and ill-defined auto turnout just north of the bridge provides public access to the shoreline of Morse Basin. A small picnic spot is located on the opposite side of Highway 16, overlooking Wainwright Basin.

Public policies contained in the Community Plan call for increased waterfront access in the vicinity of Seal Cove. The city is considering an integrated system of open space connecting Seal Cove with Hays Creek, along the northern waterfront of Prince Rupert. A pedestrian walk and limited vehicular access way are planned for the shoreline at Seal Cove. The remaining waterfront property in Prince Rupert is zoned for industrial use.

The City of Prince Rupert is well serviced with potable water, with adequate resources to accommodate growth in the mid-range future. Water is supplied by pipeline from the watershed located across Fern Passage on

the mainland. The boundaries of the watershed extend from Fern Passage, eastward beyond Woodworth Lake, and north to Osborne Cove. Access to the watershed is restricted; persons entering the area must do so through one of the stool testing stations located near Shawatlan Lake. A dam at the mouth of Woodworth Lake feeds a water pipeline and a small generator for electrical service to Prince Rupert.

The city water supply originates at Woodworth lake with an 18 inch (500mm) pipeline leading to the pump house at Shawatlan Lake. The pipeline increases to 24 inches (600mm) in diameter and carries water from both lakes through a submerged pipeline to Prince Rupert. A small electrical transmission line services the pumphouse.

Water supply for Port Simpson is provided by a watershed area on the main tributary of Stumaun Creek. A dam is located south of Stumaun Bay, and a water pipeline leads to Port Simpson.

The Rupert substation south of Morse Basin supplies electrical power to Prince Rupert through two single circuit 69 kV lines paralleling the Yellowhead 16 Highway between the substation and the bridge at Galloway Rapids. The two sets of lines cross the rapids on the northeast side of the 2-lane bridge, then travel overland toward Prince Rupert. The two single circuits pass through the Hospital Cove site and cross Highway 16 near the junction of the new Ridley Island highway.

A 25 kV line traverses Indian Reserve No. 2 between Metlakatla and Port Simpson. The power line roughly parallels an existing logging road that runs between Georgetown Lake and Stumaun Bay. Power interruptions are common, particularly in winter. Servicing is difficult due to the need to fly repair crews in by helicopter, which may be grounded in bad weather. A third power supply line runs from the small dam at Woodworth Lake to Prince Rupert, with a submerged crossing of Fern Passage at Sourdough Bay. This line supplies power to a pumphouse.

Major roadways within the study area include the Yellowhead 16 Highway, which leads directly into Prince Rupert, the Port Edward Highway along the southern shore of Wainwright Basin, and a recently built road connecting Ridley Island with Yellowhead 16 just south of Oliver Lake Park.

However, a road and/or ferry service connecting the city with Port Simpson, 32 km to the north, has been under consideration since the early 1970's. Discussions on this issue are continuing between members of the Port Simpson Indian Band and representatives of Dome Petroleum Limited. An overland highway connecting Prince Rupert with Port Simpson would require a bridge crossing at Fern Passage. Because the highway is in the early stages of consideration, no details are yet available on bridge location and design. A bridge might be constructed across Fern Passage.

Official community plans also anticipate a new road between the junction of the Ridley Island Highway and Yellowhead 16 and main entrance to the Prince Rupert Industrial Park to the north. The new road would roughly parallel Yellowhead 16 and would open this area to development.

Two major logging roads within the study area are located north of Tuck Inlet. A logging road leads from a sorting area at Tuck Inlet and beyond to a central valley, where logging operations are currently under way. Another logging road connects the northern reaches of Georgetown Lake with Stumaun Bay and Port Simpson.

3.7.3 Assessment

Important land uses within the study area include the Prince Rupert Industrial Park, the Seal Cove Seaplane Base, and Prince Rupert's watershed reserve. The industrial park and watershed could continue to provide their specific land uses if a transmission line were constructed. The issue of key concern is the seaplane base at Seal Cove. Air safety regulations would prohibit joint use of Fern Passage for aircraft operations and the passage of overhead power lines (Neal, pers. comm.). As the major transportation centre for the coastal communities in the North Coast Region, the seaplane base provides an essential service.

The housing needs of future Prince Rupert residents is a primary concern of city officials. Although growth direction policies have not been established, the likely near-term direction of growth appears to be southward, between Highway 16 and Morse Basin. The planned residential community between Butze Rapids and Oliver Lake Park will provide some of the housing needed to accommodate Prince Rupert's growth.

The use of waterfront property in Prince Rupert will become an increasingly important issue as economic growth amplifies the demand for commercial and industrial waterfront. The public park and open space needs of the residents will increase public pressure to provide access to the waterfront, especially in the vicinity of Seal Cove.

Indian Reserves within the study area are also constraining land uses in terms of transmission line routing. However, the Port Simpson Indian Band has given the Port Simpson Resource Development Committee authorization to negotiate with Dome Petroleum Limited for a utility corridor consisting of road, pipeline and powerline rights-of-way through the Georgetown Lake-Port Simpson corridor. Other smaller Indian Reserves can be easily avoided by re-routing the transmission line.

3.8 AGRICULTURE

3.8.1 Methods

The rugged terrain and poor soils of the North Coast Area have discouraged the development of commercial agriculture. To assess any impact the proposed transmission line could have on agriculture, the following steps were undertaken. An overview of the current agricultural development and development prospects for the Northwest Region was prepared. Letters were sent to government officers outlining the proposed transmission corridors and asking for their comments. The study area itself was then examined to determine if any areas of potential agricultural impact existed. Since no soils or agricultural capability maps were available, air photographs, surficial geology maps and field observations of the Terrain and Land Use consultants were used to review the agricultural potential of the study area.

3.8.2 Inventory

No soils or agricultural capability surveys have been undertaken in the study area. Government officials feel the agricultural potential of the area is too low to warrant such surveys. There are no Agricultural Land Reserves or grazing permits in the study area or anywhere on the Tsimpsean Peninsula. Responses of government field officers did not point out any areas of agricultural interest in the area and reiterated the low agricultural capability of the area.

A review of 1977 1:20,000 scale air photographs of the study area showed that no agricultural development exists at the present time in the study area. Examination of slope and terrain information showed that with the exception of the few areas discussed below, excessive slopes, muskeg and extremely thin soils with bedrock exposures limit the entire study area to class 6 and 7 for agricultural capability. Commercial agriculture would therefore be virtually impossible over almost all of the study area.

The only exceptions to the low agricultural capability of the study are small areas within terrain unit 3. This unit occurs north of Georgetown Lake in the Georgetown Lake-Port Simpson Corridor. Preliminary investigation indicates that the gently undulating areas of well drained, sandy soils within terrain unit 3 may have an agricultural capability of class 3. Crops such as potatoes or cool loving vegetables and pasture grass could be grown in these areas. These areas are good forest sites and competition from other land uses would discourage agricultural development.

3.8.3 Assessment

A wood pole transmission line in any of the proposed corridors would have no significant impacts on agriculture now or in the forseeable future. Any negative effects of the transmission line on the few arable areas such as land and time loss and interference with field operations would be offset by the value of land clearing and elimination of forestry as a competing land-use for the right-of-way.

3.9 FORESTRY

3.9.1 Methods

This analysis of potential forestry impacts examined the probable effects of a transmission line on long-term forestry activities in the area of the proposed transmission corridors. The study objectives were to assess the impacts of a transmission line on forest productivity by mapping areas of high, medium poor and low site classes and comparing the volumes of mature timber between corridor options.

The inventory of the forestry resources was based on aerial reconnaissance flights, forest cover maps (1:20,000) and discussions with Ministry of Forests personnel (Prince Rupert).

The Ministry of Forests has forest inventories of all Public Sustained Yield Units (P.S.Y.U.'s). These data are available on 1:20,000 forest cover maps, supported by map area and volume statements. Data on existing forest tenures, licensee chart (operating) areas, and forest roads were gathered directly from the Ministry of Forests (Prince Rupert.)

This information was used to map the forest site productivities and volumes of native timber for the transmission line corridors (Map 3). In addition, present chart areas and areas of active logging have been recorded.

3.9.2 Inventory

The study area is within the boundaries of the North Coast Timber Supply Area (TSA) of the Prince Rupert Forest District. Crown lands compose the overall majority of the forest lands in the study area. The area is within the newly established Hecate Provincial Forest.

The majority of the study area is covered by forest low in yield and has severe silvicultural limitations (D. Thompson, pers. comm.). The reasons are mainly high rainfall, shallow soils and poor drainage. These low

productive forests have low volumes per hectare and produce trees which are generally of poor form and high in defect. Much of this timber is unsuitable for sawmills.

The major tree species in the study area are western red cedar, yellow cedar, western hemlock, Sitka spruce and shore pine. Except for logged areas in the vicinity of Stumaun and Georgetown Creeks, the majority of the remaining forest land supports timber greater than 250 years of age. Trees are generally less than 25 m in height.

a) Forest Site Productivity

Table 3-12 outlines the distribution of forest sites in the study corridors. It is evident that low sites and non-productive forest land compose a high proportion of the study corridors, a total of 51% of the area. The remaining area is split evenly between medium and poor site.

Table 3-13 shows the mature timber volumes contained in the various study corridors. The forest types dominated by cedar species have the greatest volume in the study corridors followed by hemlock. Balsam and spruce type have relatively small volumes.

b) Access and Present Forest Activity

Access to the upland portions of the study corridors is limited. Road access is presently available in the vicinity of Stumaun, Lahon and Georgetown Creeks, (Georgetown Lake-Port Simpson and Work Channel segments) where past and present logging has taken place. Timber stands located adjacent to the water are accessible using handlogging and A-frame logging methods. Much of the merchantable timber along Tuck Inlet has been logged using these methods. Kloiya Bay and Morse Basin West segments are accessible from Highway 16.

Table 3-12. Forest Site Productivity along the Proposed Corridors.

Corridor Segment	Site Productivity (ha) Medium	Poor	Low	Non-Productive
Kloiya Bay	37	-	136	-
Morse Basin West	82	140	641	17
Morse Basin East	136	267	242	17
Denise Inlet - woodworth Lake	466	260	749	179
Shawatlan Lake	37	83	248	20
Laurier Cove	52	41	289	13
Tuck Inlet West	474	71	154	-
Tuck Inlet East	5	356	210	27
Georgetown Lake - Port Simpson	389	537	631	52
Work Channel	618	403	693	454
TOTAL	2296	2158	3993	779

Table 3-13. Volume of Mature Timber in Cubic Metres (Close utilization) Within the Corridor segments

Corridor Segments	Mature Timber Volumes ($10^2 m^3$) Cedar Types	Hemlock Types	Balsam	Spruce	TOTAL
Kloiya Bay	545.28	227.76	-	-	773.04
Morse Basin West	2117.61	644.74	-	-	2762.35
Morse Basin East	3121.84	784.86	-	-	3906.7
Denise Inlet - Woodworth Lake	6811.46	2336.87	82.82	278.43	9509.58
Shawatlan Lake	1109.47	1149.11	-	-	2258.58
Laurier Cove	1730.06	455.52	-	162.00	2347.58
Tuck Inlet West	748.75	2243.21	-	-	2991.96
Tuck Inlet East	2533.76	413.44	-	60.75	3007.95
Georgetown Lake - Port Simpson	3327.23	1841.12	-	146.81	5315.16
Work Channel	5905.72	3459.7	-	107.25	9472.67
TOTALS	27951.18	13556.33	82.82	755.24	42345.57

Present forest activity in the study corridors is limited to the upper Georgetown Creek area in the Work Channel segment. B.C. Forest Products Ltd. and Doman Forest Products Ltd. are logging in this area. This logging is scheduled for completion in approximately five years. The clearcut areas have been reforested in the Work Channel segment. No other silvicultural activities in the study area have taken place. With the exception of several handlogging chart areas along Tuck Inlet, Denise Inlet at Work Channel, and a proposed helicopter chart area above Morse Basin East corridor segment, no other existing chart areas occur in the study corridor.

3.9.3 Assessment

The forestry evaluation was based on assessment of direct losses, in particular, those which have a lasting effect on the productive forest land base. This base includes sites of different site productivities which determine the quantity and quality of the forest product. For example, good site forest land produces twice the volume of wood in slightly less than two-thirds the time than does poor site forest land. Therefore, the impact of removing good site forest land is triple that of removing poor site land. On the other hand, an evaluation of growing stock, i.e. mature and immature timber values, only views the short-term consequences of their loss. Growing stock, as represented by merchantable timber and immature timber values does not provide an adequate basis for evaluating long-term losses. Furthermore, the loss of growing stock may be mitigated to some degree by the sale of harvestable timber, or by payments made for the loss of immature timber values. However, the removal of timber from a right-of-way is carried out regardless of market condition, and therefore, during depressed markets it is less valuable. Therefore, forest site productivity was chosen as the best means of evaluating forestry impacts.

Forest cover maps (1:20,000) of the Ministry of Forests were used to identify the various site productivity classes found in the study area. Areas of good, medium, poor and low, non-forest and non-productive forests have been mapped and used as the prime long-term value determinant. Volumes of mature timber within each corridor segment were also evaluated. Each corridor segment was rated as high impact, moderate impact or low impact or no impact based on the following table.

Table 3-14. Forestry Impact Ratings

High -	Chiefly good and medium site forest land with road access within 2 km or along the shoreline
Moderate -	Chiefly medium site with no access, or poor site with road access within 2 km or along the shoreline
Low -	Chiefly poor site with no access or low site forest land
No impact-	Non-forest and non-productive forest

Medium forest sites were given a high impact rating because of the importance of these sites to the local coastal region. The area covered by poor and low sites is large, increasing the importance of productive forest sites (medium). The loss of medium forest sites could therefore have a significant impact on the local forest industry.

The site productivity classes provide an indication of the future yield of the site over the next rotation. These classes provide the best approximation of effects that future development would have on the local forest industry. In other words, the impact of alienating "medium site" class forest land is greater than if an equal portion of "poor site" forest land is traversed.

Areas of present and future forest harvesting and silvicultural activities were considered to have a modifying influence and were evaluated qualitatively where they occurred.

Thus, the best corridor segments from a forestry point of view:

1. minimize the area of good and medium site.
2. maximize the area of non-forest and non-productive forest land.
3. avoid areas where dollars have been invested to improve the site or its growing stock.
4. avoid permanent forestry research plots.
5. minimize short term losses (mature timber).

Table 3-15 indicates that no corridor segment has been rated as having a high impact. Four segments have been rated as having a moderate impact, while the remaining seven are rated as low. This is generally indicative of the low forestry values in the study area.

Table 3-15. Forestry Evaluation of Impact.

Corridor Segments	Corridor Length (km)	Site Productivity Class: % of total Medium	Poor	Low	Non-Productive	Mature Volume $10^2 m^3$	Access	Impact Rating
Kloiya Bay	2.3	21	-	79	-	773	Road	Low
Morse Basin West	12	9	16	73	2	2762	Road	Low
Morse Basin East	10.7	20	40	37	3	3907	Water Access	Moderate
Denise Inlet - Woodworth Lake	15.7	28	16	45	11	9510	Water access along Denise Inlet only	Low to Moderate
Shawatlan Lake	3.3	9	22	64	5	2259	None	Low
Laurier Cove	3.7	13	11	73	3	2348	Water	Low
Tuck Inlet West	9.5	68	10	22	-	2992	Water	Moderate
Tuck Inlet East	8.0	<1	69	35	5	3008	Water	Low
Georgetown Lake - Port Simpson	18.3	24	33	40	3	5315	Road	Moderate
Work Channel	20.0	28	19	32	21	9473	Road & Water	Low

3.10 MINING

3.10.1 Methods

A search was made of recent Mineral Claims Maps, Mineral Deposit Land Use Maps, and the Revised Mineral Inventory Map (B.C. Ministry of Energy, Mines and Petroleum Resources) for the study area to determine areas of present and potential mining activity.

3.10.2 Inventory

There are no active claims present within the proposed corridors and the entire study area is mapped as 3C (no significant deposits known, geological environment favourable, present and future exploration likely - small deposits possible). The Revised Mineral Inventory Map indicates four sites of minor significance of lead, zinc, copper, silver and gold on the west side of Tuck Inlet but the locations are not precise (within 300 m to 4 km) and there are no active claims in the area.

3.10.3 Assessment

Transmission line development in this area is not expected to have any impacts on mining because of the low mineral potential and absence of active claims within the proposed corridors.

3.11 VISUAL ANALYSIS

3.11.1 Methods

The approach for this section was adapted from methods developed by Tetlow and Sheppard for their Northeast Coal Study. The purpose of a visual analysis is to identify specific landscape units that merit protection from adverse visual impacts. Landscape units are distinguished from one another in terms of visual quality and the ability of each unit to absorb a transmission line. This information is used to guide the route selection process and to design adequate mitigation measures.

Most of the base data was derived from B.C. Forest Service aerial photographs. A scanning stereoscope was used to determine visual unit boundaries, with reference to 1:50,000 scale N.T.S. topographic maps. An overflight reconnaissance of the study area was made by heilcopter in late September, 1982. A followup flight in mid-October allowed photographs to be taken of particular visual details. Two days were spent driving and walking to public viewpoints in and around Prince Rupert.

Extensive photographic coverage of the study area was obtained on 35 mm colour film. Photographs served to corroborate preliminary findings on unit boundaries and features. No public surveys or opinion polls were conducted in the course of this study; the visual analysis is based on the consultant's observations, opinions, and judgement. Reference was made to terrain, land use, and recreation mapping carried out by other team members to corroborate scenic elements and vulnerability.

Conducting the visual analysis for the Prince Rupert-Grassy Point study involved a three-step process of inventory, assessment, and recommendation for each of the potential corridors. The inventory

portion required mapping and ranking visual units according to topographic type, slope, vegetation, unique features, elevation, man-made modifications, and natural degree of contrast. The assessment step analyzed these units with respect to visual vulnerability to transmission structures, exposure of the corridor, distance between a transmission line and viewing stations, skylining potential where a transmission facility interrupts the visible line between earth and sky, visibility from the community and the likelihood of public objections. Recommendations were then developed to avoid and mitigate adverse visual impacts due to transmission line routing.

In developing a workable inventory of the visual environment, the alternative corridors were first divided into visual units. A visual unit is a subdivision of a particular landscape determined from physiographic character, aerial photographs, and from overall impressions of the study area. Units usually bound an observer's field of vision and represent a degree of unity and character based on landscape form, topography, colour, and texture. Map 6 illustrates the visual inventory for the study region.

Each visual unit was then assessed with respect to scenic distinction and ranked as either vivid, distinct, or indefinite in visual quality. Landscape units expressing strong visual strength in landform, vegetation, and colour with positive cultural modifications (where present) were ranked as vivid. Landscapes which have typical topography with some variety and interest in vegetation, colour, and land use were ranked as distinct. Visual units with little strength or variety with respect to the above characteristics were ranked as indefinite. Figure 3-2 presents the key factors used in evaluating scenic distinction. The visual vulnerability of the landscape unit was assessed from its potential to screen a transmission line or otherwise avoid public viewing. Scenic features such as water, mountain peaks, inlet mouths, and man-made

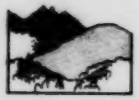
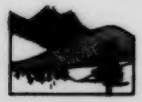
	LANDFORM	VEGETATION	WATER	COLOUR	CULTURAL MODIFICATIONS	REGIONAL CONTEXT
						
VIVID	High vertical relief (e.g. prominent cliff, spires or massive rock outcrops); severe surface variation or highly eroded formations; or dominant and exceptional detail features such as glaciers.	Variety of vegetative types in interesting forms, textures and patterns.	Clear and clean appearing, still or cascading water, which is a dominant factor in the landscape.	Rich colour combinations, varied or vivid colours; or pleasing contrasts in the soil, rock, vegetation, water or snow fields.	Cultural modifications add favourably to visual variety.	Distinctive, unusually memorable, or very rare within region.
DISTINCT	Steep canyons and mountains; interesting erosional patterns or variety in size and shape of landforms; or interesting but not dominant or exceptional detail features.	Some variety of vegetation, but only one or two types.	Flowing or still, but not dominant in the landscape.	Some intensity or variety in colours and contrast of the soil, rock and vegetation, but not a dominant scenic element.	Scenic quality is somewhat depreciated by inharmonious intrusions, but not so much that it is largely negated; or modifications add little or no visual variety to the area.	Distinctive, though somewhat similar to others within the region.
INDEFINITE	Low rolling hills, foothills or flat valley bottoms; few or no interesting detailed features.	Little or no variety or contrast in vegetation.	Absent, not noticeable, or of poor quality.	Subtle colour variations, contrast or interest; generally muted tones.	Modifications are so extensive that scenic qualities are substantially reduced or almost nullified.	Interesting within its setting, but fairly common in the region.

FIGURE 3-2: KEY FACTORS USED IN EVALUATING SCENIC DISTINCTION

Source: Adapted from Tatlow and Sheppard, 1977.

modifications were considered in estimating the potential visual impact of a transmission line.

Following the assessment, specific recommendations were developed to adopt a route alignment that would avoid adverse effects and mitigate unavoidable impacts. Priority was given to protecting landscapes of scenic value in the study area.

3.11.2 Inventory and Assessment

a) General Description of Study Area

Most of the visual units comprising the study area represent recognizable flooded-valley forms, where tide-governed waterways are enclosed by forested slopes and mountain ridges. There are no prominent cliffs, spires, or massive rock outcrops, no glaciers or notable waterfalls, and no rich colour combinations recorded for the study area. Consequently, the visual units were limited to rankings of distinct and indefinite.

The Prince Rupert vicinity is important in a regional context as the western terminus of the Yellowhead 16 Highway, which winds west from Jasper over the Alberta border. Prince Rupert is also the western-most stop of the Canadian National Railway, the northern port of the B.C. Ferry System, and the southern extreme of the Alaska Ferry System. Tourists and other visitors to the Prince Rupert region engage in sightseeing by car, bus, charter boat, fixed-wing aircraft, and helicopter. Views from Yellowhead 16 and the streets and parks of Prince Rupert are important to the visitor in developing an overall impression of the region.

Although the water-mountain slope interface is a common view in Prince Rupert, certain portions of the study area are particularly susceptible to visual impacts due to their proximity to the community and Yellowhead

16. The sensitive areas are the shoreline reaches and high slopes surrounding Morse Basin, Fern Passage, and Prince Rupert Harbour.

Also notable is the occurrence of low clouds, rain, and fog which quite often obscure the views within the study area. Occasionally, smoke from the pulp mill at Port Edward contributes to a dense haze in Morse Basin that can adversely affect the scenic quality of the study region.

The following subsections present the visual units, inventory of visual qualities, and assessment of sensitive areas for each of the alternative corridors under consideration. Refer to Map 6 for an illustration of the visual units and sensitive areas.

b) Kloiya Bay Corridor

The topography of this corridor includes a low elevation prominence adjacent to Yellowhead 16, a 100m knoll guarding the mouth of Kloiya Bay, and the waters of both Morse Basin and Kloiya Bay. The visual unit contains little variety in vegetation, colour, contrast, or elevation. The unit includes the electrical substation serving Prince Rupert and two 69 kV transmission lines parallel to Yellowhead 16, a water delivery pipeline and right-of-way, and portions of the old Highway 16. The prominent knoll separating Kloiya Bay and Denise Inlet (noted as point "B" on Map 6) is a focal point for boaters and shore visitors. In general, the Kloiya Bay visual unit is ranked as indefinite in visual quality.

Although Yellowhead 16 runs close to the substation, roadside vegetation would effectively screen any new transmission line constructed between the station and Kloiya Bay. Due to the low elevation of this land, a transmission line could be hidden from the view of boaters on Morse Basin as well. However, the prominent knoll at the mouth of Kloiya Bay will pose some problems; a linear element crossing the knoll or a transmission

structure placed on the crest would be highly visible to boaters and recreation beach users in the vicinity.

Morse Basin West Corridor

The corridor which follows Yellowhead 16 into Prince Rupert is divided into three visual units: 1) Galloway Rapids, 2) Morse Basin Lowlands, and 3) Seaplane Base.

Galloway Rapids Visual Unit includes the kilometre-long stretch of beach from the substation to the bridge, the crossing of Galloway Rapids, and a short ridge segment to the north. In addition to the bridge crossing at the rapids, other man-made structures include two 69 kV transmission lines on wood poles crossing Galloway Rapids just east of the bridge, and remnants of old Highway 16 running roughly parallel to Yellowhead 16. From the bridge, the view of Morse Basin includes a 1 km expanse of water to the opposite shore, where thickly forested slopes lead to 700 m (2,100 feet) peaks. The bridge crossing is the first visual opportunity for motorists to view Morse Basin to the east and Wainwright Basin to the west. This is the major factor in ranking the Galloway Rapids Visual Unit as distinct in visual quality.

The visual unit demonstrates a good capability for absorbing a transmission line. Roadside vegetation could screen the line from motorists between the substation and the bridge. Adding a third set of lines to those already spanning Galloway Rapids would do little to further degrade the visual quality. Views of Morse Basin are restricted to north-bound traffic and, at normal speeds for the bridge (45 kph) are limited to a few seconds only. There is no convenient auto turnout near the bridge, although a short gravel drive exists to the north. For these reasons, public objections to an additional transmission line in this visual unit are unlikely, in the consultant's opinion.

Morse Basin Lowlands Visual Unit extends from Hospital Cove to Grassy Bay, and includes the rolling hills and lowlands between Yellowhead 16 and Morse Basin. Shoreline views are limited by 25-30 m trees rimming Morse Basin, restricting inland vistas to 100 m or less. Similarly, roadside vegetation confines the motorist's view along Yellowhead 16 to less than 50 m. The unit is considered indefinite in terms of visual quality for the region.

Because of the prevailing low topography and limited access to much of the corridor, the visual unit has a good potential for absorbing a transmission line. Vegetation and shallow depressions could screen a transmission line from the highway and from boaters on Morse Basin between the Ridley Highway junction and the Butze Rapids viewpoint. From this point northwards, the line would pass through a BCDC industrial development area that could accommodate the transmission line.

The Seaplane Base Visual Unit contains the northern-most section of the corridor from Grassy Bay to the Seaplane Base at Seal Cove, and across Fern Passage to the low ridgeline above Prince Rupert Harbour. The topography is generally of low relief, ranging from sea level to 30 m. The dominant visual feature of the unit is Fern Passage and the uneven shoreline on both sides. The land is thickly forested on the east side of the passage, and mostly developed with industrial buildings on the west side. A bridge has been proposed to cross Fern Passage at Seal Cove to support a road leading to Port Simpson. This unit is ranked as indefinite in visual quality.

A transmission line in this visual unit (especially one that crosses Fern Passage with overhead lines) would be considerably exposed to the community. Visitors to Seal Cove and Sourdough Bay would find views to the eastern shore and distant mountains were degraded by such a line. The City of Prince Rupert is considering plans to construct a pedestrian walkway and waterfront park extending from Hays Creek to Seal Cove.

Therefore, public objections to an overhead crossing at this point may be high, in the consultant's opinion.

d) Morse Basin East Corridor

This corridor, in many respects, is the most sensitive of all of the alternatives in terms of visual disturbances from transmission line development. The corridor is divided into three visual units from south to north: 1) Morse Basin Elbow, 2) Butze Rapids, and 3) Shawatlan Lake.

Morse Basin Elbow Visual Unit presents an interesting visual feature that dominates Morse Basin. The topography slopes gradually from sea level to pronounced peaks and ridges at an elevation of 700 m (2,100 feet). Slanting fracture lines create a unique pattern in the vegetation that uniformly covers the slope. When viewed from Galloway Rapids, intermediate ridges are recognizable on the eastern slopes. Although a few cabins sit near the shoreline north of the elbow, no man-made alterations are visible within this unit. Because of the interesting patterns and overall dominance of the slopes within Morse Basin, the visual unit is ranked as scenically distinct.

Any linear development along the exposed slopes of this unit will be highly visible. A transmission line would have to first span the mouth of Denise Inlet, and would be visible to boaters using local waters. The clear zone for a transmission line traversing the "corner" and heading north would be visible from the bridge at Galloway Rapids, the shoreline at Hospital Cove, and from boats in Morse Basin. Proposed residential areas south of Butze Rapids would have a clear view of a transmission line across Morse Basin. Because of the high visibility and dominance of the unit in the Morse Basin landscape, public objections to a transmission line may be strong, in the consultant's opinion.

Butze Rapids Visual Unit encompasses the low lands between Butze Rapids and the outlet of Shawatlan Lake. The topography represents a flattened bench near the shoreline, between the unnamed peaks above Morse Basin and Shawatlan Lake. Elevations gradually increase with a gentle slope from sea level to about 170 m (500 feet) at the base of the peaks. Vegetation and colour are mostly uniform throughout the unit, with no visible man-made alterations. A feature of visual interest lies at Butze Rapids, a well-publicized tourist viewpoint. From the roadside stop, the visitor can observe swift tidal currents foaming through several interesting channels at Butze Rapids. The unit is ranked as distinct in scenic quality, largely because of the presence of Butze Rapids.

This visual unit demonstrates a fair ability to absorb a transmission line. Exposure of the line could be minimized by avoiding the shoreline and higher slopes. The Butze Rapids viewpoint on the old Highway 16 would provide a clear view of any linear development in this unit, but a transmission line would not be obvious if carefully routed. According to the consultant's assessment, public objections are likely to be moderate.

Shawatlan Lake Visual Unit is a low relief area of rolling hills adjacent to Fern Passage and Shawatlan Lake. The unit shows low contrast and variety in terms of colour, vegetation, and elevation. An existing transmission line runs through the unit connecting Prince Rupert with a small dam at Woodworth Lake. A second electrical line runs to a small pump house on Shawatlan Lake, and a water pipeline passes from a dam at the Lake to Fern Passage, where it runs submerged to Prince Rupert. The visual quality for this unit is ranked as indefinite.

The varied terrain and dense vegetation provide good opportunity to screen a transmission line from view. However, the route must be carefully selected to avoid ridge lines and to take advantage of the numerous valleys.

e) Denise Inlet-Woodworth Lake Corridor

The alternative corridor that follows Denise Inlet to Woodworth Lake is divided into five visual units: 1) Denise Inlet, 2) Denise Creek, 3) Bannock and Mahlon Lakes, 4) Woodworth Lake, and 5) Shawatlan River.

Denise Inlet Visual Unit presents an integrated landscape of quiet waterways and forested slopes on both sides. Although the water-land interface is found frequently in the study area, Denise Inlet represents a pristine and tranquil flooded valley with 850 m (2500 foot) peaks to the north and 500 m (1500 foot) peaks to the south. The mouth of Denise Inlet is distinct with a prominent 100 m (300 foot) knoll serving to visually isolate the inlet from the open waters of Morse Basin. The Denise Inlet Visual Unit is ranked as distinct in visual quality.

A transmission line in this unit, if it crossed the mouth of the inlet and traversed the north slopes, would be visible to boaters using Denise Inlet. Because the sun's orientation leaves the south slopes in shadow in the winter months, consideration should be given to running the line along the southern side of the inlet. If the knoll at the inlet's mouth was avoided, public objections to a transmission line in this unit should be moderate, in the consultant's opinion.

Denise Creek Visual Unit is an area of varied relief and elevation. Rising from sea level at Denise Inlet, the topography climbs forested slopes to peaks reaching 700 m (3,000 feet) in elevation. Denise Creek is not prominently visible, except at the mouth where low tide deltas and mudflats are frequently exposed. No man-made modifications are visible in the unit; however, a gas pipeline has been proposed to cross Denise Creek from southeast to northwest. The high peaks and exposed slopes surrounding the creek lead to a ranking of distinct visual quality.

There would be little problem with concealing a transmission line in the visual unit, especially if the proposed corridor were followed. A prominent ridge to the north of the creek would effectively screen an electrical right-of-way from viewers at the mouth of the creek.

Bannock and Mahlon Lakes Visual Unit consists of a small area of two lakes located in a shallow mountain pass. The lowlands in the pass are mostly boggy muskeg presenting a wide range of greens, yellows, and golden browns. Surrounding slopes are densely forested except where slides have exposed light-coloured bedrock. Because of the variety in colours, vegetation, and texture, the unit is ranked as distinct in visual quality.

Mahlon Lake and the northern half of the visual unit lie in the established watershed reserve for Prince Rupert; access to the watershed is restricted. Because few observers visit this area, public objections to a transmission line are unlikely, in the consultant's opinion.

Woodworth Lake Visual Unit presents a highly varied topography ranging from lake level elevations at 100 m (300 feet) to the surrounding peaks at 850 m (2500 feet). Although the unit lacks contrast in vegetation and colour, the setting of Woodworth Lake is visually interesting. The Woodworth Lake Visual Unit is ranked as distinct in quality. Watershed restrictions in the Woodworth Lake area have kept this region free from regular human contact.

Shawatlan River Visual Unit is composed of rolling hills and gently sloping mountainsides which enclose the Shawatlan River and Lake. The river is screened by thick forest cover in most places, except where construction of the water pipeline and small transmission line have exposed the river banks. The unit demonstrates a low level of contrast in vegetation, colour, and topography, and has been ranked as indefinite

in visual quality. The entire visual unit is restricted by virtue of the watershed designation.

f) Shawatlan Lake Corridor

Two visual units are designated in the short corridor north of Shawatlan Lake: 1) Harbour Slope Visual Unit, and 2) Shawatlan Lake Visual Unit.

Harbour Slope Visual Unit rises gently from the waterline at Prince Rupert Harbour along an exposed slope to a 200 m (600 foot) peak. Due to the repetition of this type of landscape in the study region, the visual unit is ranked as indefinite in quality.

Because of the exposure of the harbour slope and proximity to the community of Prince Rupert (4 km), this visual unit has a poor capability to absorb any linear development. Boat tours of Prince Rupert Harbour and Tuck Inlet bring observers within 1/2 km of the exposed slope in this unit.

Shawatlan Lake Visual Unit is an area of low rolling hills and shallow folds, densely forested and demonstrating little contrast in colour, vegetation, or form. The visual quality of this unit is ranked as indefinite. A transmission line could be easily hidden within this unit, and shielded from the community and the harbour by the dominant ridgeline and 200m peak to the west.

g) Laurier Cove Corridor

The Laurier Cove corridor consists of two visual units: 1) Osborne Cove, and 2) Laurier Cove.

Osborne Cove Visual Unit includes a small shallow cove enclosed by slopes reaching a few hundred metres in elevation. The mouth of Scissors Creek

is visible to boaters, although the creek is not prominent within the visual unit. Vegetation and colour show little contrast and variety, and there are no man-made alterations visible within the unit. The visual quality of the unit is ranked as indefinite.

A transmission line would not be conspicuous in the southern sector of the unit where the exposed slope is shallow and thickly forested. A linear right-of-way in the northern sector, where the slope increases, would be more noticeable.

Laurier Cove Visual Unit forms an interesting and, at lower tides, colourful contrast to the green forested slopes which rise quickly on both sides. The volume of space enclosed by Laurier Cove and the proximity of Tuck Point give the unit an interesting visual perspective. The visual quality of the unit is ranked as distinct. A transmission line in this visual unit would be highly exposed, especially where the route would round each of the prominent shoulders guarding the cove. The northern slope faces Prince Rupert and is visible from the community, although, at a distance of 12 km, details may not be clear to most observers. A transmission line at Laurier Cove would be most noticeable to tourists on cruise boats and recreational boaters passing to Tuck Inlet.

h) Tuck Inlet West Corridor

Tuck Inlet West Visual Unit is the only subdivision within the corridor and forms an effective western border to the landscape of Tuck Inlet. Slopes on both sides of the inlet draw attention to the two focal points on this long and narrow body of water: the headwaters of Tuck Inlet, and Tuck Point. Vegetation is relatively even, except where slide areas have been overgrown with alders. Except for a short logging road near the headwaters of the inlet, no man-made alterations of the natural

environment are noticeable. The visual quality of the Tuck West Unit is ranked as distinct.

Because the forested slopes within the unit show little diversity or contrast, a transmission line would be very noticeable. The greatest impact to the visual environment would result from crossing Tuck Narrows with an overhead transmission line. This line would be highly visible to tour and recreational boats passing between Tuck Inlet and Prince Rupert Harbour.

i) Tuck Inlet East Corridor

Tuck Inlet East Visual Unit is the only unit identified for the corridor, and is similar in nature to the Tuck Inlet West Unit. However, the eastern slopes demonstrate more variety in topographic form and vegetation pattern. Exposed, moderate slopes dominate the landscape near Laurier Cove, but quickly graduate to a bench (at 100 m [300 feet]), north of the cove. Further north, slopes increase again and lead to the 800 m (2400 foot) elevation at Sharp Peak. A logging operation is located near the head of the inlet, visible as a logging road and a dozen structures. The visual quality of the unit is ranked as distinct.

Because of the presence of terrain benches on the eastern side of Tuck Inlet, and the existence of a logging camp and road, the transmission line could be hidden from view (from Tuck Inlet) for nearly half of the unit's length. Public objections would likely be less than for the west side of Tuck Inlet, primarily because there would be no need to cross Tuck Narrows.

j) Georgetown Lake - Port Simpson Corridor

The corridor is comprised of three visual units: 1) Georgetown Lake, 2) Mount Ben, and 3) Stumaun Bay.

Georgetown Lake Visual Unit presents an elongated lake nearly surrounded by flat terrain, with little variety in the vegetation types, colour, and texture of the adjacent lands. More mountainous terrain is found on the east side of the lake, however, where Basil Lump reaches an elevation of 800 m (2500 feet). Because of the availability of this type of landscape within the study area, the visual quality of the unit is ranked as indefinite. Exposure of a transmission line in this unit could be reduced by using available benches and minor depressions to screen the line from Georgetown Lake. A new line could follow the existing 25 kV electrical line from a point just north of Georgetown Lake, which accompanies a logging road running toward Stumaun Bay.

Mount Ben Visual Unit contains a moderately varied topographic form representing a broad valley between two peaks: Mount Ben to the east and Mount Griffin to the west. Much of the exposed hillside of Mount Griffin has been logged, disrupting an otherwise consistent vegetative cover. The quality of this visual unit is ranked as minimal. Band members may pursue hunting, fishing, or trapping within the visual unit. However, exposure of a transmission line would be low.

Stumaun Bay Visual Unit consists of a long reach of shoreline bordering the western side of Stumaun Bay. The elevation range is low, from sea level to 100 m (300 feet), and the topography consists of low relief slopes with no exposed cliffs or rock outcrops. A small inland lake (Neaxtoalk Lake) provides a measure of contrast and colour. The quality of the Stumaun Bay Visual Unit is ranked as indefinite.

There are good opportunities to screen a transmission line from Stumaun Bay in the southern sector of the visual unit. If care is taken to avoid the shoreline and exposed ridges north to Neaxtoalk Lake, the transmission line could be absorbed into the environment.

k) Work Channel Corridor

The long Work Channel corridor consists of five visual units: 1) Little Georgetown Lake, 2) Little Georgetown Creek, 3) the Pass, 4) Work Channel, and 5) Zumtela Bay.

Little Georgetown Lake Visual Unit contains a small lake and moderate slopes in an active logging area. Due to the current logging operations, which include several logging roads and spurs, the visual quality has been degraded to some degree. Exposed earth and underbrush provide some variety in color and texture, but the overall impression is negative in terms of value. Visual quality in this unit is ranked as indefinite.

A transmission line in this unit would be unavoidably exposed due to the lack of natural screening vegetation. However, the area is not visible to any community and, because of the extensive visual impact from logging operations, public objections to a transmission line in this unit are unlikely.

Little Georgetown Creek Visual Unit includes another logged area upstream of Little Georgetown Lake. Portions of the broad valley floor have been clearcut, exposing earth forms and underbrush on both sides of a 5 m wide creek, which drains the major watershed in this vicinity. Logging roads are highly visible within the valley, and debris litters the valley floor. Visual quality for this unit is ranked as indefinite.

Exposure of a transmission line in this unit is unavoidable because of the absence of tree cover.

The Pass Visual Unit includes a high mountain pass leading from the Little Georgetown Creek to Work Channel. The terrain is interesting in this area, because the pass sits at an elevation of 400 m (1,300 feet) between two peaks that reach 490 m (1,600) and 600 m (2,000 feet). The vegetation and colour contrasts are interesting at the pass, with exposed gneiss rock, muskeg, and small ponds displayed in random patterns. Although the pass is virtually inaccessible, except by helicopter, it does provide substantial views of the mountainous region to the northeast, and the Ensheshese Valley beyond Work Channel. No man-made alterations are visible in the natural environment. The visual quality of the Pass unit is ranked as distinct.

Because of the dominance of muskeg and rock at the pass, there is little natural forest available to screen a transmission line. A transmission line could be skylined at the pass (as seen from Work Channel), although care could be taken to minimize this exposure.

Work Channel Visual Unit consists of the exposed slopes flanking Work Channel from the pass to Trail Bay. The terrain is somewhat varied along this unit, with several ridges and gullies dividing the unit into visual segments. Vegetation and colour show low contrast and variety, except where slides have removed the natural forest vegetation. The overall visual quality of the Work Channel Visual Unit is ranked as distinct.

A linear development in this visual unit would be visible for many kilometres, particularly in winter months when snow would fill the cleared zone of the right-of-way. There are few natural screening features available for use, and the high elevation and steep slopes would enhance the exposure of a transmission line. Additional work is needed to identify alternative routes within this corridor that would minimize adverse visual impacts. Public objections are expected if a 10 km

stretch of this environment were marred by a poorly routed transmission line.

Zumtela Bay Visual Unit consists of a low relief, shallow valley connecting Zumtela Bay with Neaxtoalk Lake. Elevation ranges between sea level and 90 m (300 feet), flanked by George Hill to the south and Lizzie Hill to the north. The unit shows little variety or contrast in vegetation or colour, and no evidence of man-made alterations. The Zumtela Visual Unit is ranked as indefinite in quality.

Because of the low elevations and rolling nature of the terrain, there ample opportunity to screen a transmission line from Trail Bay. The unit is not visible from an existing community.

3.12 RECREATION

3.12.1 Methods

Recreational features within proposed transmission line corridor segments were inventoried and subjectively evaluated according to present and potential use. Possible impacts and mitigation alternatives were identified to be used in corridor segment evaluations. Recreation features were mapped using the Canada Land Inventory recreation capability format and feature symbols.

The inventory included scenic terrain, beaches, sheltered moorages, level shoreland suited for camping, picnicking and cottaging, hiking corridors and locations known to have concentrations of fish or game.

Feature identification and use estimation was accomplished with a review of existing pertinent literature and interviews with B.C. Forest Service, Parks Branch and Ministry of Tourism personnel.

The importance of recreation features was assessed using C.L.I. capability ratings and personal interpretations derived from a two-day helicopter reconnaissance of the study area. A primary consideration was alteration of access through transmission line construction, and its effects on use potential.

Impacts of the proposed transmission line on identified recreation resources were rated and presented in tabular form. Negative impacts such as alteration of scenic natural settings, animal populations or distributions, and alienation of potential recreation development land were rated as to severity using the scale in Table 3-17. Only areas of moderate impacts were shown on the inventory map (Map 6).

Positive impacts such as the development of new recreation opportunities from creation of access and subsequent site improvement (facility construction) were also considered. These positive impacts have been

discussed in the text, and used in corridor evaluations. In cases where mitigating actions may reduce the effect of a negative impact, the rating has been adjusted to one of less severity.

Those features considered to be important were designated on an inventory map. Moderate potential impact ratings were included on the map. No critical impacts were identified.

Table 3-16. Recreation Impact Rating Definitions

Impact Rating	Definition
High	Long term loss, degradation or destruction of highly significant recreation resources such as beaches, significant shorelands, wildlife viewing areas or potential high use camping or cottaging areas. This includes actual or potential parks, recreation reserves, resort facilities or unique natural features in remote areas.
Moderate	Loss, degradation or destruction of important recreational features such as attractive natural settings (waterfalls, boat moorages, beaches etc.) or partial degradation of highly significant recreation resources.
Low	Some undesirable change to areas of moderate recreational capability such as small beaches or campsites with difficult access.
None	No undesirable impacts to recreationally important areas.

3.12.2. Inventory

Prince Rupert, Port Simpson and Metlakatla are the three settlements found within the Tsimpsean Peninsula. Metlakatla is not within the current study area. Port Simpson, an Indian fishing village, can be accessed by boat and seaplane at present, while Prince Rupert is serviced by Highway 16, the CN railway, commercial air service and ocean going ships. The City of Prince Rupert possesses golf, tennis, playground, campground and park facilities (Oliver, Diana and Prudhomme Lakes), as well as two local ski developments (Mount Hays and Mount Ptarmigan). Big game and waterfowl hunting on the Tsimpsean Peninsula is restricted to the coastal fringe, due to lack of land access. Recreational boating and angling occurs on all ocean waters, with the majority being concentrated near the islands of Digby, Ridley and Smith. Sport fishing (halibut and salmon) and crabbing occurs on the east sides of Chatham Sound between Metlakatla and the Skeena River to the south. Some scuba diving, cross country skiing and hiking occurs in the Prince Rupert area (Hinton et al, 1975).

Recreation opportunities desired by the local population include:

1. Development of ocean swimming beaches, preferably in estuarine areas where warmer water prevails.

2. Construction of additional campgrounds, picnic sites and boat launches.

3. Improved access to cottage development areas or other recreationally valuable lands.

4. Provision of additional scenic driving opportunities. (Hinton et al, 1975).

Current restrictions to recreational land use include the Woodworth Lake Community watershed, extensive Indian Reserve lands south of Port Simpson, and log booming leases in Prince Rupert Harbour and Tuck Inlet.

Hunting on the Tsimpsean Peninsula is restricted to waterfowl, deer, bear and wolf. B.C. Fish and Wildlife hunter sample statistics revealed that up to 4,500 licensed hunters reside in the Prince Rupert area, with the major hunting effort taking place outside of MU 6-14 (of which the Tsimpsean Peninsula is a part). Native hunting effort and locations should be considered, although little information is available at present.

According to Prince Rupert Tourism Bureau statistics, an estimated 180,000 people visit Prince Rupert by air, ferry, train, bus or recreational vehicle each year. No details were available concerning people entering the area by passenger car. The proportion of these visitors likely to use newly accessed recreation features is not known. However, it can be assumed that demand for a diversity of recreational attractions far exceeds the current supply. This is true not only in the context of tourism, but also from the perspective of local residents desiring weekend and vacation activity areas.

Discussions with B.C. Forest Service (Bill Jackson pers. comm.) and Parks Branch (Bob Dalziel, pers. comm.) personnel indicated that no plans have been made for recreation developments in the Tsimpsean Peninsula area. Mr. Dalziel did mention however, that the Parks Branch was interested in maintaining the natural integrity of Work Channel, and may, at a future time, support construction of boat launch and picnic facilities to promote recreational opportunities in the area, if road access were available.

Table 3-17 lists all features shown on Map 6 along with potential negative impact ratings and explanation of any feasible mitigating actions. Potential positive impacts have not been mapped, but are explained in section 3.12.3.

Potential hiking trails are not shown on the map. In general, it can be assumed that potential for hiking trail development exists adjacent to most stream courses and low gradient shorelines. Constraining factors include presence of muskeg, dense forest cover and steep terrain.

Pleasure boating occurs in the Morse Basin, and Prince Rupert Harbour areas. Tuck Inlet experiences some tour boat use, although log booming restricts the Inlet's capability for recreation. Work Channel also receives minimal use due to the difficulty of access. Small boats must be launched at the Khyex River logging road to the south, which is some distance from Prince Rupert, while large vessels must skirt the Tsimpsean Peninsula, entering from the north. This area has high scenic potential which could be exploited if road access accompanied transmission line development.

Although Georgetown Lake is not accessible for boating at present, it does have moderate capability for it as well as angling (cutthroat trout), camping and swimming. According to Hinton et al (1975), this area could provide a resort or cottage development for Port Simpson. Georgetown Lake is also connected to Big Bay by a creek with an adjacent hiking trail. Big Bay is attractive recreationally because of resident and transient avian populations and the historic sawmill site (Georgetown Mills).

Table 3-17. Assessment of Potential Impacts on Recreation Features.

Corridor Segment	Location	Features	Impact Rating*
1. Kloiya Bay	East and West Shores	Deep water boat moorage and family boating existing picnic site at head of Bay	N
2. Denise Inlet-Woodworth Lake	North shore of Denise Inlet	Extensive shoreland suitable for campgrounds, boat launches and deep water moorage	N
	Denise Creek estuary	Gravel bars used for camping, fishing and wildlife observation. Some potential for hiking along the creek exists.	L
	Bannock Lake	Low capability for wildlife observation and camping, constrained by boggy terrain.	L
3. Morse Basin East	Entire shoreline	Sheltered areas have moderate capability for small cottages, beaches and good moorage sites occur at several locations	M
	Butze rapids	Scenic location	M
4. Morse Basin West	Entire shoreline	Potential for campground, beach and residence development	L
5. Laurier Cove	Laurier Cove, Silver Creek	Moderate potential for hiking, nature study, angling, boat moorage and camping	M

Continued/2

Table 3.17 continued.

Corridor Segment	Location	Features	Impact Rating*
6. Tuck Inlet East	Small shoreline strips	Sites suitable for camping or cottage development. Constrained by log booming leases. This area is also used for deer hunting.	L
7. Tuck Inlet West	Small shoreline strips near Tuck Point	Moderate potential for camping and boat moorage. This area is also used for deer hunting.	L
8. Georgetown Lake Port Simpson	Georgetown Lake Shoreline	Moderate potential for camping, swimming and cottaging. Best on northwest and southwest shores.	L
	Stumaun Bay	Sand beach and shoreline areas suitable for lodging.	M
	Neaxtoalk Lake	Area suitable for, camping and angling on west shore.	L
9. Work Channel	Small shoreline strips at sheltered areas	Low suitability for lodging with small cobble beaches present.	L
	Zumtela Bay	Moderate to high capability for camping, lodging and boat launching facilities. Deep water moorage is also available.	L

* Impact Ratings (see table 3-16 for definition)
H - high
M - moderate
L - low
N - none

3.12.3 Assessment

Although Prince Rupert is both a major population centre and the western extremity of Highway 16, a well travelled tourist route, few recreational opportunities exist. According to Hinton et al (1975), the limitations of high rainfall (250 cm + annually), ocean fog, boggy terrain, water barriers and lack of access roads have precluded the use of recreation resources on the Tsimpsean Peninsula. A transmission line extending to Grassy Point would affect only one of these limitations; road access. The transmission line access road would be for construction and maintenance purposes. As a result, it may or may not be open for public access, depending on the severity of problems such as vandalism and liability. Since the LNG terminal service road would have controlled access, it is not known to what extent it will be used for recreational purposes. If the Port Simpson Indian band is allowed unlimited use of the road, then areas identified as having recreational potential will most certainly experience increased use.

In general, any new access to the areas listed in Table 3-17 would be beneficial in terms of improving recreation opportunities. Negative impacts at all these locations could be eliminated by placing structures away from significant shoreland features at "slope toe" positions. This would not be possible at Silver Creek, as the steeply sloping creek valley has little room for a transmission line and shoreline recreational facilities.

The majority of locations suitable for recreational development in the Morse Basin West corridor segment are constrained to some extent by existing plans for industrial and residential development. (See Section 3.9). Ritchie Point, located at the northeast corner of Prince Rupert, may be developed as a municipal park which would have some scenic view problems if the opposite shore is chosen for the transmission line (Morse Basin East).

The Morse Basin East corridor segment contains some good shoreland with beaches and sheltered moorage. There are at present three recreational lease properties in this area. Depending on whether access is improved by construction of a road open to the public, power line construction could enhance opportunities for additional cottage or residence development.

A natural feature of significance is Butze Rapids. The scenic value of this feature could be protected through judicious transmission line placement on either of the Morse Basin corridors.

The Stumaun Bay area has moderate potential for beach and logging development, and could provide considerable opportunity were it given road access. A large portion of the western shore has been used as a dry land log sorting area and barge landing. As a consequence, some of the backshore areas have been levelled. Also, a portion of the 'sand' and 'flag' beach foreshore has been filled to provide deep water for barge landings. This combination of level terrain, existing logging roads, beach and man-made promontory would be conducive to cottage development. Transmission line routing plans on the last leg of the Port Simpson-Georgetown Lake corridor segment could allow for the protection of views from the above mentioned areas. This is discussed in Section 3.11.

The bottleneck area between Neaxtoalk Lake and Zumtela Bay will of necessity be the focus for pipeline, road and transmission line development. Because of this, the area deserves careful scrutiny. As mentioned by Mr. B. Dalziel, Regional Parks Planner, this area could provide opportunities to combine a day-use area and boat launch facilities on either side of the Tsimpsean Peninsula. This option should be examined in light of the land use conflicts this may create for the LNG terminal and the residents of Port Simpson.

3.13 HERITAGE RESOURCES

3.13.1 Methods

The Heritage Conservation Act of British Columbia (1977), administered by the Heritage Conservation Branch of the Ministry of the Provincial Secretary and Government Services, requires all major land altering activities affecting lands considered to contain heritage sites or objects, to take into account potential heritage resources in light of adverse impacts whch may affect them. The purpose of this overview, is to provide the developer with an assessment of the heritage resource potential of the proposed corridors for the Rupert-Grassy Point transmission line so that construction can proceed with minimal disturbance to prehistoric and historic sites.

To provide an adequate data base for such an assessment, the following procedures were employed:

- A search was made of the Provincial Heritage Site Inventory Files, the Provincial Inventory of Historic Buildings and the Provincial Inventory of Designated Heritage Sites. The records for all sites located within or in close proximity to the proposed corridors were obtained. Site locations were then plotted on the 1:50,000 development map.

- A library search of previous archaeological, historical and environmental studies within the study area was conducted to gain an appreciation of the nature and extent of the heritage resource potential.

Archaeological research in the study region was initiated by Smith of the National Museum of Canada. Between 1898 and 1927 Smith conducted intermittent site reconnaissance programs and minor test excavations in the Prince Rupert Harbour area (concentrating on Kaien Island) (Smith 1909; MacDonald and Inglis 1980). This was followed in 1938 by Drucker of the Smithsonian Institute who carried out an archaeological site

survey and testing program along the north coast of British Columbia (Drucker 1943). His research concentrated on the sites in Venn Passage and Digby Island. In 1954, Borden conducted test excavations at a midden site (GbTo 10) on Kaien Island near the outskirts of Prince Rupert. Intensive archaeological research only began in 1966 when George MacDonald of the National Museum of Canada initiated the north coast prehistory project, a major research program designed to detail the development of the elaborate and highly integrated cultural pattern known historically in the Coast Tsimshian area (MacDonald and Inglis 1980).

During the course of the north coast prehistory project, the Prince Rupert Harbour area and adjacent Tsimpsean Peninsula were surveyed for archaeological sites with close to 250 sites being recorded. Major excavations conducted at 11 of the sites in the Prince Rupert Harbour area have produced sufficient data to outline a regional history extending back some 5,000 years (MacDonald and Inglis 1980).

In addition to the north coast prehistory project, a number of smaller heritage resource programs have been carried out in the region in response to various industrial development proposals. In 1974 Inglis conducted a heritage resource impact evaluation in the Kaien Island area in response to the proposed Heilbroner Estate industrial development (Inglis 1974b). May (1979) conducted a salvage excavation of a winter village (GbTn 19) on Ridley Island threatened by construction of a bulk loading facility and the Heritage Conservation Branch conducted small scale heritage resource inventory and evaluation programs associated with proposed highway developments on Kaien Island (Mackie and Montgomery 1977; Wright 1979).

There are five heritage resource projects of direct relevance to the present study. In 1980, an overview was prepared of a proposed LNG plant site on Kaien Island (ARESCO 1980). Two additional overviews of the study region were prepared the following year. The first (ARESCO 1981a), concerned the Grassy Point LNG plant and the associated Work Channel pipeline. The second overview was of 12 proposed export terminals for

the RIM GAS project (ARESCO 1981b). One of these terminals was the Grassy Point site. Subsequent to the preparation of these overviews, an archaeological inventory and impact assessment was conducted of the proposed Grassy Point LNG plant (ARESCO 1982). The project of greatest significance to the present study is the archaeological inventory of a proposed National Harbour Board bulk loading facility conducted in 1974 by Inglis (Inglis 1974a). The majority of previously located sites known for the proposed corridors for the Prince Rupert-Port Simpson transmission line was recorded in conjunction with this project. This work was extensive in terms of its regional scope. As a result, probably most of the major coastal sites easily identifiable from water were recorded. However, because of the broad scope of the study, inventory was not always intensive and thus many unrecorded coastal sites are undoubtedly still present. Inland areas were not addressed in this study.

3.12.2 Inventory

a. General Description of Study Area

The study area is within the traditional territories of the Tsimshian Indians whose major areas of habitat are the Prince Rupert Harbour area and along the Nass and Skeena Rivers (Garfield and Wingert 1979). The Tsimshian Indians are a linguistically distinct group of coastal people adapted to varied environmental conditions on both sides of the Coast Range. Ocean resources provided the majority of food stuffs including eulachon, herring, various clams and sea plants, sea lions, halibut and rock cod. On the mainland bear, deer, berries and various roots, shoots, and barks were utilized. Rights to resource areas were claimed by kin whose social organization comprised a complex system of phratries and clans (Garfield and Wingert 1979). On the basis of existing ethnographic research, sites to be expected in the coastal portion of the study area include winter villages, marine resource gathering and processing localities. Inland, small, transitory campsites reflecting single, short term usage (perhaps relating to hunting or gathering activities) are expected.

The historic period in the study area began almost 200 years ago with the initial contacts made by sea-based fur traders. The first land-based, full time contact occurred in 1831 with the establishment of Fort Nass at the mouth of the Nass River by the Hudson's Bay Company (ARESCO 1980).

The effect of this early contact on the traditional lifeways of the Tsimshian was minimal. "It was not until the influx of the first missionaries that relationships became more direct, and the Indians were encouraged to give up their traditional ways" (Inglis 1974a:C3).

Sites dating to the historic period likely to be found in the study region are fish processing locales and camps, sawmills and lumbercamps.

b) Kloiya Bay

There are no previously recorded heritage resource sites within this study segment. One prehistoric site, GbTn 9, a general activity-shell midden site is situated nearby, in Lot 646A, on the west side of Kloiya Bay (see Map 6).

The area of this segment most likely to yield heritage resources and thus considered of high potential is the shoreline of Kloiya Bay and Morse Basin. The zone between the shoreline and base of the slope (about 60m (200 feet a.s.l.) would be considered of a moderate potential but the existing disturbance, the highway, water pipeline, transformer station, and transmission line has downgraded this assessment to low. A rating of low potential has been assigned the slope area west of Highway 16.

c) Morse Basin West

A total of eight heritage resource sites are known from the Morse Basin West study zone. These sites, GbTn 1, 2, 4, 5, 6, 10 and GcTn 8 and 9 are all recorded as general activity - shell midden sites (Map 6). Data for these sites are presented below in the order in which the sites occur, i.e. south to north.

- GbTn 1 (General activity - Shell midden)
  Location: 54° 18' 52" N 130° 15' 47" W
  West shore of Fern Passage
  Dimensions: 7.6 m x 22.9 m x 1.1 m
  Condition: Good (1966)

- GbTn 10 (General activity - Shell midden; Canoe skid)
  Location: 54° 19' 11" N 130° 16' 01" W
  West side of Fern Passage
  Dimensions: 15.2 m x 6.1 m x 0.5 m
  Condition: Site area has been cleared and logged (1974)
  Miscellaneous Data: Canoe skid and cabin present.

- GbTn 2 (General activity - Shell midden)
  Location: 54 19' 54" N 130° 17' 04" W
  Near Seal Cove, within Prince Rupert
  Dimensions: Undetermined
  Condition: Possibly destroyed (1966)
  Miscellaneous Data: Site was occupied until circa 1834.

- GbTn (General activity - Shell midden)
  Location: 54° 19' 44" N 130' 16' 06" W
  West shore of Fern Passage, within Prince Rupert
  Dimensions: Undetermined
  Condition: Good (1974)
  Miscellaneous Data: Shack present

- GbTn 6 (General activity - Shell midden)
  Location: 54° 19' 54" N 130° 16' 25" W
  opposite David Point, within Prince Rupert
  Dimensions: Not determinable
  Condition: Destroyed by filling (1966)

- GbTn 4 (General activity - Shell midden)
  Location: 54° 19' 58" N 130° 16' 8" W
  Inlet south of David Point
  Dimensions: Localized deposit
  Condition: Good (1974)

  GcTn 8 (General activity - Shell midden)
  Location: 54° 20' 18" N 130° 16' 20" W
  South shore of Pethick Point
  Dimensions: "Small"
  Condition: Good (1974)

  GcTn 9 (General activity - Shell midden; Village site)
  Location: 54° 20' 06" N 130° 16' 10" W
  David Point
  Dimensions: Unrecorded
  Condition: Excellent (1974)
  Miscellaneous Data: At least five house depressions present.
  This is an extensive village site (Inglis 1974a).

Two shell midden sites, GcTn 10 and GbTn 21, are situated close to the segment. The former is of particular significance in that it was excavated in 1927 by Harlan I. Smith of the National Museum. Forty-three artifacts were recovered from this large site situated at Seal Cove.

The entire shoreline of Morse Basin is considered of high potential. Several sites, though now disturbed, are known from the Seal Cove, Fern Passage area. Additional sites would undoubtedly be recorded from this area though, they too, would likely be disturbed. This disturbance reduces the significance of the site data and hence the inherent site value. The remaining portion of Morse Basin West is considered low in potential with one general exception. The banks of creeks and lakes are considered to be moderate in potential.

d) Morse Basin East

Ten heritage resource sites are known from the Morse Basin East corridor. With the exception of one (GbTn 20), all sites are shell middens. Site locations are plotted on Map 6.

- GbTn 16 (General activity - Shell midden)
  Location: 54° 16' 02" N 130° 12" 34" W
  North shore of mouth of Denise Inlet
  Dimensions: Approximately 22 m x 23 m x 0.4 m
  Condition: Good (1974)
  Miscellaneous Data: Some recent historic remains

- GbTn 15 (General activity - Shell midden)
  Location: 54° 17' 18" N 130° 14' 24" W
  East coast of Morse Basin
  Dimensions: Small, localized deposit, greater than 0.3 m in depth
  Condition: Unrecorded (1974)

- GbTn 14 (General activity - Shell midden)
  Location: 54° 18' 10" N 130° 14' 28" W
  East shore Morse Basin, below Butze Rapids
  Dimensions: 20 m in length x 0.6 m in depth
  Condition: Good (1974)

- GbTn 11 (General activity - Shell midden)
  Location: 54° 18' 21" N 130° 14' 40" W
  East shore of Fern Passage, north of Butze Rapids
  Dimensions: Localized deposit
  Condition: Good (1974)

- GbTn 13 (General activity - Shell midden)
  Location: 54° 18' 27" N 130° 14' 36" W
  East shore of Fern Passage, north of Butze Rapids
  Dimensions: 30.5 m x 13.7 m
  Condition: Good, some slumping (1974)

- GbTn (General activity - Shell midden)
  Location: 54° 19' xx" N 130° 14' 40" W
  Tsimpsean Peninsula
  Dimensions: 61 m x 15.2 m x 2.4 m
  Condition: Cabins in ruins, otherwise unreported
  Miscellaneous Data: Four summer cabins present (1974)

- GbTn 20 (Isolated find - Canoe skids)
  Location: 54° 19' 34" N 130° 15' 16" W
  Shawatlan Bay
  Dimensions: Undetermined
  Condition: Good (1974)
  Miscellaneous Data: Site recorders note shore area should be be examined for associated midden deposits.

- GbTn 3 (General activity - Shell midden; Canoe skids; Fish weirs)
  Location: 54° 19' 41" N 130° 15' 25" W
  Near Shawatlan Falls
  Dimensions: 50.3 m x 6.1 m x 1.8 m
  Condition: Undisturbed (1966)
  Miscellaneous Data: Site has long been utilized as a salmon fishing locale.

- GbTn (General activity - Shell midden)
  Location: 54° 19' xx" N 130° 15' xx" W
  On creek draining Shawatlan Lake
  Dimensions: 9.1 M x ? x 0.9 to 1.8 m
  Condition: Unrecorded (1966)

- GbTn (General activity - Shell midden; Canoe skids, Modern cabin)
  Location: 54° 19' 28" N 130° 15' 50" W
  East shore Fern Passage
  Dimensions: 30.5 m x 3 m
  Condition: Cabin still in use (1974), otherwise unreported

The shoreline of Morse Basin and Fern Passage has demonstrated high heritage resource potential. In addition, the area around the Shoowahtlans Indian Reserve 4, Shawatlan Lake and River are also considered to possess high potential for sites. All creeks flowing to the ocean on this part of the peninsula are judged to have moderate heritage potential along their banks. The rest of this corridor has low potential.

e) Shawatlan Lake

Heritage resource sites have not been recorded for the Shawatlan Lake corridor.

Because this study segment is removed from any permanent body of water, in this case the Prince Rupert Harbour, a low heritage resource potential rating is assigned.

f) Laurier Cove

Four shell middens have been recorded within this segment. Site data are presented below.

- GcTn 7 (General activity - Shell midden)
  Location: 54° 22' 42" N 130° 14' 42" W
  East side of Osborn Cove
  Dimensions: 15.2 m x 9.1 m x 1.2 m
  Condition: Good (1974)

- GcTn 6 (General activity - Shell midden)
  Location: 54° 22' 45" N 130° 14' 40" W
  East side of Osborn Cove
  Dimensions: 30.5 M x 3.1 m
  Condition: Has been logged, garbage on surface (1974)

GcTn 5 (General activity - Shell midden; Historic - Sawmill)
Location: 54° 22' 56" N 130° 14' 36" W
Northern limit of Osborn Cove
Dimensions: 61 m x 15.2 m x 3.1 m
Condition: Good (1974)
Miscellaneous Data: Possible village site; historic sawmill remains present on surface (1974).

- GcTn 1 (General activity - Shell midden)
Location: 54° 23' 40" N 130° 14' 40" W ?
East side of Laurier Cove, conflicting locational data presented
Dimensions: Depth probably less than 1 m. Other dimensions not specified
Condition: Some disturbance (1967)

All portions of this corridor adjacent to Prince Rupert Harbour are considered high in heritage resource potential. The banks of Scissors and Silver Creeks and the two unnamed creeks are rated moderate. The remainder of this study segment is considered low in potential.

g) Denise Inlet - Woodworth Lake

There are neither prehistoric nor historic sites known for the Denise Inlet - Woodworth Lake corridor.

The shores of Denise Inlet are considered likely to yield archaeological sites so a rating of high has been assigned. The remainder of the corridor is considered of low potential with several exceptions. All banks and terraces associated with creeks, rivers and lakes are designated moderate in potential. These are, from the south: two unnamed creeks flowing into Denise Inlet; Denise Creek and its tributaries; Bannock, Mahlon and Woodworth Lakes and their associated unnamed creeks; and the Shawatlan River.

h) Tuck Inlet West

GcTn 2, a prehistoric shell midden site at Tuck Point, is the only known heritage site within this proposed corridor. Site data are presented below.

- GcTn 2 (General activity - Shell midden)
  Location: 54° 23' xx" N 130° 15' 30" W
  Tuck Point
  Dimensions: Not determined
  Condition: Undisturbed (1967)

The shoreline adjacent to Tuck Inlet is of high heritage resource potential whereas all creek banks are considered moderate in potential. The remaining area of this corridor consists of steep sideslopes. These are of low heritage resource potential.

i) Tuck Inlet East

There is one known heritage resource within the proposed Tuck Inlet East corridor. It is a small shell midden site situated about 1.5 km north of Tuck Narrows.

- GcTn 4 (General activity - Shell midden)
  Location: 54° 24' 26" N 130° 15' 55" W
  East shore of Tuck Inlet
  Dimensions: Unrecorded
  Condition: Good (1974)

As with the other proposed corridors, the shoreline is considered high in heritage resource potential. The banks of the unnamed streams are moderate in potential and all other areas are low.

j) Georgetown Lake-Port Simpson

GdTo 52 on Stumaun Creek at the south end of Stumaun Bay was recorded in 1974 although cultural deposits were not discovered. The creek and associated tidal pools are known to have been utilized in the historic period by the Tsimshian Indians. It is the only known archaeological site in the Georgetown Lake-Port Simpson Corridor. An additional site, GdTo 23, an historic shell midden at Grassy Point, is, however, near the northern terminus. This site was investigated by ARESCO in conjunction with a survey of the proposed LNG plant (ARESCO 1982).

- GdTo 52 (Resource utilization - Natural fish trap)
  Location: 54° 33' 15" N 130° 23' 12" W
  Stumaun Creek
  Dimensions: Unrecorded
  Condition: Good (1974)

Only the northern coastal and Neaxtoalk Lake portions of this corridor are considered high in heritage resource potential. From Stumaun Bay north a rating of high is assigned the coastal areas of the Georgetown Lake-Port Simpson corridor. The banks associated with Georgetown Lake and its tributaries as well as those associated with Stumaun Creek and its tributaries are considered moderate in potential. All other portions of this study zone are rated low in heritage resource potential.

k) Work Channel

Five heritage resource sites are known from the proposed Work Channel corridor. All possess shell midden deposits. One is also a village site. Site data are summarized below.

- GdTn 3 (General activity - Shell midden)
  Location: 54° 30' 26" N 130° 16' 26" W
  Small bay, south shore of Work Channel
  Dimensions: Approximately 10 m x 13 m x up to 2.4 m
  Condition: Good

- GdTn 5 (General activity - Shell midden)
  Location: 54° 30' 40" N 130° 16' 40" W
  South of a small creek, south shore of Work Channel
  Dimensions: 3.1 M x ? x 0.9 m
  Condition: Good (1974)

- GdTn 4 (General activity - Shell midden; Canoe skid)
  Location: 54° 30' 45" N 130° 16' 42" W
  South shore of Work Channel, opposite Legace Bay
  Dimensions: Approximately 10 m x 4 m x 2.4 m
  Condition: Good (1974)

- GdTo 4 (General activity - Shell midden; Village site)
  Location: 54° 33' 48" N 130° 20' 0" W
  Trounte Point, south shore of Work Channel
  Dimensions: 70 m x 10 m x 6 m
  Condition: Good (1974)

- GdTo 5 (General activity - Shell midden)
  Location: 54° 34' 44" N 130° 21' 42" W
  South shore of Zumtela Bay
  Dimensins: 7 m in length, other dimensions unrecorded
  Condition: Good (1974)

In addition to these five sites within the proposed Work Channel corridor, three sites are situated nearby. GcTn 11, a shell midden site, is located on the south shore of Work Channel. GdTo 6, another shellfish processing locale, is situated at the northeast point of Zumtela Bay and GdTo 23, the historic shell midden site previously evaluated (ARESCO 1982), is at the site of the proposed LNG plant at the northern terminus of this proposed corridor.

The probability of encountering previously unrecorded sites along the coast of Work Channel is high. In particular, sites are likely to be recorded at the outlet of small streams and in protected bays. Another zone of high potential is the area between Zumtela Bay and Neaxtoalk

Lake. This area may have served as a travel corridor between Work Channel and Port Simpson Bay. The inland portions of all streams and the terraces of the small lake are considered moderate in potential. A low rating is assigned all other areas of the proposed Work Channel corridor.

3.13.3 Assessment

Thirty heritage resource sites have been identified in the 10 proposed corridors. The majority are shell midden sites, i.e. shellfish processing locales. Few of these small sites with midden deposits have been excavated hence their exact nature and function within the overall resource utilization pattern is largely unknown.

Areas of heritage resource sensitivity have been delineated. Generally, coastal areas are considered high in potential; river, creek and lake shores and terraces are considered of moderate potential for the recovery of new heritage resource sites; and all other areas are considered low in potential. Coastal areas are considered likely to yield village sites, shell midden sites, fish weirs, and canoe skids. Inland, prehistoric sites will likely be lithic scatters. Coastal sites would have been directed at utilization of marine resources while inland sites at the procurement of land mammals as well as various roots, shoots, and berries. It should be noted that previously inland areas have not received the attention that has been directed towards the coastal zones. Because of this, inland sites are virtually unknown. Because the sea resources were so plentiful and easily procured, they formed the focus of prehistoric subsistence patterns. Thus, large village sites will be marine oriented. Historic sites most likely to be recorded are fish and lumber camps as well as small sawmill sites. Heritage resource potential rankings are the same for the recovery of both prehistoric and historic sites.

Potential Impacts

Transmission line development can result in impacts to heritage resource sites, primarily during construction stages, although more minor impacts can also occur during operational stages. Right-of-way clearing is probably the most significant potential impact to heritage sites. Removal of timber and brush by heavy equipment or even by hand can cause extensive ground disturbance resulting in the loss of heritage resource information. This initial operation would impact all but the most deeply buried sites within the right-of-way. Stump removal, following initial clearing, would further disturb heritage sites, particularly those with buried components.

Access road construction poses another serious threat to heritage resource sites. Impacts would be similar to those described in right-of-way clearing, but would also include potential disturbance from grading and cut and fill operations not usually associated with line development.

The final potential impact to heritage resources is structure installation. Excavation for structure foundations and heavy equipment operation could damage sites not already disturbed from right-of-way clearing.

During the operation phase, damage to heritage sites may result from maintenance traffic eroding archaeological materials. There is also increased danger of vandalism and amateur collecting at sites because of improved access.

4.0 GENERAL MITIGATIVE PROCEDURES

Potential impacts of the proposed transmission line have been discussed in Section 3.0. Although there could be some beneficial impacts, e.g. increased access for forestry development, recreation, most of the impacts were judged to be negative.

The individual resources differ in their response to various mitigation measures. For example, impacts as a result of crossing critical ungulate winter range or high value forest sites are not easily mitigated, and generally require avoidance. These impacts must be considered at the corridor selection phase. On the other hand, disciplines such as terrain and fisheries generally have fairly site-specific impacts that can be mitigated by using different structure designs, engineering practice or construction windows.

The majority of the environmental resources evaluated indicate that certain general mitigation measures can be stated and should be adhered to as general practice for any transmission line while others form the basis for the more site-specific mitigation measures (Section 5.0). The following sections present discipline-specific mitigative measures.

4.1 Terrain and Water Resources

A number of common sense engineering practices can be instituted that lessen the chance of slope failures and soil erosion, and the subsequent impacts they would have on adjacent water, vegetation, and forestry resources. These are described below:

1. Clearing of low vegetation (shrub understory) on steep slopes (>30%), and building of spur roads, should be minimized to avoid soil erosion and debris slides.

2. Use of tracked vehicles on organic soils on slopes of >30% near streams and lakes should be voided. Hand clearing and rubber-tired vehicles should be used.

3. Construction in bogs (muskeg and blanket bogs) should be avoided wherever possible. Access roads should skirt bogs. Poles necessary in deep muskeg should be erected by helicopter, or if the bogs are trafficable, only rubber-tired vehicles should be used.

4. Access road crossings of salmon streams must be approved by local fish and wildlife personnel. Bridges and culverts should be of sufficient size to pass the design. (see note below). A single bridge should be constructed to serve all facilities in the common corridor, and temporary bridges and fords should not be used in the survey and early construction phase.

5. Tree and shrub cover, which provides shade and bank protection, should not be removed from the banks of fish-bearing streams or lakes. If necessary for transmission line crossings, tall trees should be selectively felled or topped.

6. When constructing the line through the Woodworth Lake watershed, the "Guidelines for Watershed Management of Crown Lands used as Community Water Supplies" (B.C. Ministry of Environment, 1980) should be followed.

(Note: For the protection of community watersheds, the provincial Ministry of Environment (1980) recommends sizing culverts and bridges to pass the 25 year flood. The federal Department of Fisheries and Oceans (Toews and Brownlee, 1981) recommends designing for the 100 year flood to protect fish habitat. In practice, there is insufficient hydrologic data on the north coast to calculate the 25-year or 100-year floods, and the design flood is best estimated by examining channel dimensions and high

water marks at the site. Local federal fisheries and provincial forestry officials should be consulted regarding the design of stream crossings.)

4.2 Vegetation

All transmission line impacts to vegetation are negative due to the necessity to remove or disturb natural habitats. Mitigation options can either be complete avoidance or some form of engineering practice that would minimize the area disturbed or rehabilitate the disturbed area. The lessening of impacts with approved engineering practices are designed to protect adjacent vegetation habitats or speed the natural vegetation succession on the right-of-way.

The removal of the existing vegetation from the right-of-way would require revegetation of the right-of-way to prevent secondary impacts such as erosion. The revegetation program should be designed to assist the natural revegetation processes and speed up their invasion and development on the right-of-way. Wherever possible, the natural vegetation should be left undisturbed.
The following mitigative measures to reduce or avoid these impacts are recommended:

1. Rare plants or plant communities and areas of sensitive vegetation types should be avoided.

2. Where avoidance is not possible, disturbance should be minimized, and revegetation programs should be undertaken as soon as possible to accelerate natural vegetative processes. Plant species selected for revegetation programs must possess certain characteristics such as low growth stature, longevity, cover production, erosion control ability, resistance to disease, and aesthetic value. The aim of revegetation efforts is to select and use plant species which are able to provide self-supporting plant communities on various

disturbed areas. Native plant communities are good indicators of the best species to use in revegetation, as they are likely to be resistant to local diseases and are best adapted to local environmental conditions. However, they are both difficult to obtain and to germinate.

3. Use of engineering practices designed to protect adjacent vegetation habitats or to facilitate natural vegetation succession on and around the cleared rights-of-way can reduce impacts. Culverts should be installed and maintained to minimize the effects of drainage interruption and to ensure that any changes that do occur are localized.

4. Proper fire precautions would be required during construction activities.

In summary, it can be stated that the main method of mitigating potential adverse impacts on significant vegetation resources is complete avoidance. Other mitigation methods such as limiting disturbances to a minimum area, immediate revegetation, supplying proper drainage and preserving as much of the natural vegetation along the right-of-way are merely methods designed to minimize the area affected or prepare the site for quicker re-establishment of the natural vegetative cover.

4.3 Fish

Within the study area a number of the streams support resident and anadromous fish populations. Careful construction practices and an understanding of the fish species life cycles can mitigate most adverse impacts. Several general mitigation measures can be applied to alleviate major impacts. These are as follows:

1. Siltation of spawning beds and rearing habitat should be reduced by the following measures:

   - Avoid road building, use helicopter construction techniques
   - Use boats to obtain access to the right-of-way wherever possible
   - Avoid steep hillsides
   - Minimize road construction "cut and fill"
   - Use rubber-tired equipment to minimize soil and vegetation disturbance
   - Use backhoes to reduce sidecast-end haul road bed material where practical
   - Place structures and roads at least 50 m from streams

2. Limit disturbance and removal of spawning gravel:

   - If a crossing is necessary, a bridge of adequate specifications should be built in winter to avoid spawning periods - these should be built prior to clearing of right-of-way to minimize stream crossings
   - Avoid creek crossing with heavy equipment during critical periods (See Table 4-1)
   - Cross at a single spot to localize damage
   - "Rake out" silt and/or replace stream gravel after construction ends

3. Denudation of creek bank vegetation can be reduced if construction crews:
   - Cross creeks at right angles to minimize denudation
   - leave streamside vegetation where it will not interfere with transmission line or remove the taller vegetation to create a low-growing shrub layer

4. Blockage of stream channels can be eliminated by:

- Building construction roads away from creekbank
- Using proper culverting for drainage (See Toews and Brownlee, 1981.)

5. Adhering to the construction window based on the fish spawning periods would drastically reduce any negative impacts. Construction near the streams should only take place during the summer months as indicated in Table 4-1.

4.4 Wildlife

The two most important general mitigation procedures relevant to the proposed corridors include:

1. Restriction of vehicle access to transmission line. This is important over the entire length of the chosen right-of-way, for protecting areas of wildlife concentration from overhunting, poaching and harassment.

2. Use of clearing and vegetation control techniques to promote the growth of high quality ungulate forage species. Spruce-hemlock and riparian habitats should be emphasized as they have high value as winter range. Hand clearing methods can be used in sensitive steep areas such as at Silver Creek.

4.5 Land Use and Settlement

Adverse impacts to land use and settlement resources can be mitigated in three general ways: 1) Routing the line away from sensitive land uses, 2) Designing the transmission line right-of-way for use by others, and 3) Compensating landowners who are subjected to severe impacts.

Table 4-1. Construction Window based on fish spawning chronology.

Waterbody	Probable Construction Window*											
	J	F	M	A	M	J	J	A	S	O	N	D
Denise Creek	———							———				
Shawatlan Creek	———							———				
Silver Creek	———							———				
Prince Rupert Harbour												
Tuck Inlet												
Georgetown Creek and Lake				—								
Lahon Creek	———							———				
Stumaun Creek	———							———				

* horizontal lines represent periods when spawning incubation and fry emergence is taking place.

In many cases, land use conflicts can be limited by routing transmission lines away from residential development, alienated land, and areas with development potential. When it becomes necessary to cross an area with settlement values, the route should be chosen first of all to minimize the length of the crossing. The line can be located with less impact where residential densities are lower than in areas of urban or suburban development. The alignment should respond to the pattern of development by following lot lines, access roads, or woodlots away from residences.

When a high voltage transmission line traverses an area with existing or potential land uses, the right-of-way disrupts the integrity and continuity of development. Particularly in residential areas, a right-of-way acts to divide a neighbourhood into two parts with an intervening gap. Although the transmission line does not interfere with movement across the right-of-way, its presence increases the time and distance of travel through the neighbourhood. The preferred location for a right-of-way is therefore on the edge of communities or neighbourhoods where the disruptive influence will be minimized.

Other land uses can be significantly restricted by the introduction of a transmission line. A watershed which is supplying a community with drinking water can be degraded if transmission line construction within it causes erosion and siltation. The mitigation techniques to minimize soil and water disturbances used within water supply areas include: hand clearing, limited access, and a ban on the use of herbicides.
The treatment of the right-of-way and the design and location of the structures should be suited to the land uses through which the line passes. Within residential areas, use of the right-of-way should be encouraged. In rural densities, the easement could be considered for use by adjacent land owners for gardens or other appropriate activities. However, access for maintenance purposes can create conflicts with individual uses. Consequently, community-oriented uses are preferred.

The right-of-way could provide a variety of linear park facilities including horseback riding trails, bicycle paths, walking trails, jogging or fitness circuits, play lots, or decorative planting areas. The specific uses should be determined in consultation with the community.

In the event that settled areas must be crossed where a route cannot be found which will not directly affect residential development, compensation will be paid to affected landowners in accordance with established practices.

4.6 Forestry

The primary and most significant impact of transmission line development on forestry would be the loss of productive forest land as long as the line is in service. The B.C. Ministry of Forests has estimated that, in the next 20 years, some 18% of the total productive forest land base in the Prince Rupert Forest Region will be eliminated, due to a variety of developments (including transmission lines), which would utilize valley bottoms or lower mountain slopes, often the most productive forest lands.

Mature growing stock will be lost due to right-of-way clearing for the transmission line and access roads. Some of this mature timber may not be economically harvested especially in areas where stands are sparse or decadent or where rough terrain and limited access are evident.

The loss of immature growing stock, particularly as these stocks generally cannot be economically harvested and represent the base of the future forest industry, is a potential impact of transmission line development.

Potential impacts can be reduced or avoided by applying the following mitigative measures:

1. Whenever possible, productive forest lands should be avoided.

2. Losses of mature timber values in the proposed rights-of-way could be reduced by the prompt harvesting of merchantable timber in the rights-of-way.

3. Losses of immature timber values in the proposed rights-of-way would generally not be easily mitigated; therefore, immature stands on good sites should be avoided.

4. Where major access roads would have to be built for the proposed transmission lines, the planning and development of these roads should be undertaken in conjunction with other resource developers and users. The provision of adequate lead time would enable resource planning agencies and industry to work with B.C. Hydro to plan major access roads that would serve all users.

5. In order to minimize disruptions to harvesting operations, B.C. Hydro should provide the Ministry of Forests and Forestry industry officials advance notice of the locations of rights-of-way and clearing schedules.

6. In order to reduce the risk of insect and disease infestation, a comprehensive plan should be developed for the clearing and clean-up of rights-of-way and for the maintenance of clean-up of windfalls and accumulations of debris along rights-of-way.

4.7 Visual Analysis

Measures to reduce the adverse effects of visual impacts of a transmission line include two major action categories: 1) Adjusting route alignment, and 2) Designing aesthetic improvements in lines that cannot be hidden from view.

The most obvious method of reducing impacts is to avoid areas of high visual sensitivity. By locating the transmission line away from natural features, such as ridges, shorelines, and promontories, visual impacts may be relocated to landscapes which are better able to absorb them. The route should not oppose natural topographic lines because viewer attention is drawn away from the natural landscape and towards the utility. The transmission line route should follow natural contours and be located away from ridges and crestlines.

Mitigation measures include the use of topographic features and vegetation to screen the transmission line from view. Structure locations should be integrated with landform patterns to route the line behind hills and within shallow depressions. Flat topography and dense vegetation provide many opportunities to screen the proposed transmission line. Steep slopes should be avoided because the line cannot be effectively screened by trees. By lowering or removing the utility from the ridgeline, visual impacts can be reduced.

In urban settings where visual impacts could be severe, consideration can be given to placing the transmission line underground or submerged beneath a water surface. Lines can also be routed along existing right-of-ways, roadways, or bridges to take advantage of landscapes that have already been disturbed. Including transmission lines in common corridors with roads and pipelines can reduce the net impacts of all developments on the visual environment.

Design principles could be used to mitigate transmission line impacts in areas where the line would be exposed to public view. Wood poles can be used instead of painted metal lattice structures. The height of the poles can also be adjusted to conform to the height of nearby trees. The distance between poles can also be adjusted to avoid sensitive water courses or rock outcrops.

Because there are few straight lines found in nature, the clear zone within and adjacent to the right-of-way should vary in cut width. Fires and insect infestations result in some variation in colour, texture, and vegetation patterns, and a clear zone could use irregular lines to blend with the natural landscape. Clear zones should be cleaned of debris and engineered to provide proper drainage and avoid unsightly erosion.

4.8 Recreation

Since transmission line development provides positive benefits to recreation resources and opportunities, it is important to protect against negating these benefits through destruction of scenic views and routing over sites suitable for recreation facility development.

The following is a list of recommendations which would provide access benefits without negative impacts:

1. Locate transmission line on slope toe positions or on level benches some distance from shore.

2. Avoid beach areas suitable for camping and day use such as Stumaun Bay.

3. Use routing away from natural features of scenic potential such as Zumtela Bay and Neaxtoalk Lake.

4.9 Heritage

Transmission line construction typically involves right-of-way clearing and grading as well as structure construction. These activities naturally disturb the ground surface and would have a severe impact on any heritage resources. Obviously, any mitigation with respect to the heritage sites would be avoidance. While excavation is an alternate method of mitigation, it is not preferable. No other types of mitigation exist. Thus early identification of heritage sites followed by proper route location are imperative.

5.0 CORRIDOR SEGMENT SUMMARIES - POTENTIAL IMPACTS AND SPECIFIC MITIGATION

This section of the report contains summary evaluations for each corridor by discipline in the following order:

5.1 Kloiya Bay
5.2 Morse Basin West
5.3 Morse Basin East
5.4 Denise Inlet-Woodworth Lake
5.5 Shawatlan Lake
5.6 Laurier Cove
5.7 Tuck Inlet West
5.8 Tuck Inlet East
5.9 Georgetown Lake-Port Simpson
5.10 Work Channel

Each specialist presents a summary of the major potential impacts and mitigation proposals for the eleven alternative corridor segments. Because the transmission line will not noticeably affect climate, this subject has not been included in the following discussion. However, climate can affect the construction and maintenance of the transmission line and this will be considered where appropriate. Impacts to agricultural lands and mining sites are not expected because of the absence of these resources within the study area. Agriculture and mining have also been dropped from this analysis.

A brief discussion of the potential impacts of the common corridor is included at the end of each corridor summary, where applicable.

5.1 Kloiya Bay

Terrain - No areas of sensitive terrain would be affected. The corridor is typified by organic soils over thin glacial deposits or bedrock.

Vegetation - No significant impacts to the vegetation of the corridor are expected.

Forestry - No significant impacts to the forestry resources of the corridor are expected.

Water Resources - No significant impacts to the water resources of the corridor are expected.

Fish - No significant impacts to fish resources of the corridor are expected.

Wildlife - No significant impacts to the wildlife resources of the corridor are expected.

Land Use - No significant conflicts with land use or settlement plans within the corridor are expected.

Visual Resources - Visually sensitive areas within the corridor include the roadside strip adjacent to Yellowhead 16 Highway, the shoreline of Morse Basin, and the prominent knoll at the mouth of Kloiya Bay.

The 100 m knoll at Kloiya Bay is highly visible to users of Morse Basin, Kloiya Bay and Denise Inlet. A cleared right-of-way on the exposed slopes of the knoll would reduce the visually pristine character of this important feature. Structures placed on top of the knoll would result in a "monument" effect, visible for four km or more. To avoid the exposed slopes and visible summit, the right-of-way should cross Kloiya Bay to

the south of the knoll, bend around the knoll to the east, and cross Denise Inlet as far east as possible.

Recreation - No significant impacts to the recreation opportunities of the corridor are expected.

Heritage - No significant impacts to heritage resources of the corridor are expected.

5.2 Morse Basin West

Terrain - A large portion of Kaien Island between Highway 16 and Morse Basin is covered with shallow discontinuous bog (unit 1a) and deep bog (unit 8). These bogs should be avoided when building roads to service the transmission line. The east slope of Mt. Oldfield and the north slope of Mt. Stewart (on the southern boundary of Map 1) are subject to debris slides, which have damaged the existing transmission line in the past.

Vegetation - A large bog/bog woodland complex occurs north of Hospital Cove and effectively covers half the width of the corridor. Because of the high sensitivity rating of this vegetation type as a result of its floristic diversity and possible occurrence of rare and unique plants, it should be avoided. A route following the eastern boundary of the corridor would achieve this. Where avoidance is not possible, any disturbances should be limited to the structure sites with limited road construction.

Forestry - No significant impacts to the forestry resources of the corridor are expected.

Water Resources - No significant impacts to the water resources of the corridor are expected.

Fish - No significant impacts to fish resources of the corridor are expected.

Wildlife - No significant impacts to wildlife resources of the corridor are expected.

Land Use - The proposed transmission line could potentially conflict with current and future land uses at five locations. A transmission line routed through the planned residential development acreage south of Butze Rapids could restrict uses, and divide the property into east and west sections. The route of the line should be coordinated with city planners and engineers if this corridor is selected. At Grassy Bay, a small Indian Reserve for the Wilnaskancaud Band occupies the shoreline; this could be easily avoided. Planned residential infill areas near Seal Cove and Sourdough Bay could also be avoided by consulting with city planners.

The most severe land use impact would occur at Seal Cove, where current seaplane operations provide transportation services for the North Coast region of B.C. The obvious hazards of operating an air base close to overhead transmission lines would result in the relocation of Seal Cove air services. Relocating the busy seaplane base, if a suitable waterfront location could be found, would be costly and disruptive to the commercial, industrial, and service users at Seal Cove. This impact could be avoided by either using a submerged cable (assumed to be prohibitively costly), or crossing to the mainland at a point farther south. For example, a crossing from the industrial land south of Grassy Bay may reduce aircraft hazards to acceptable levels and eliminate the need for relocating the seaplane base.

As a final point, transmission line development at Seal Cove should be coordinated with city planners to accommodate a proposed waterfront park connecting Seal Cove with Hays Creek Park.

Visual Resources - Potential visual impacts within the corridor include possible degradation of the roadside of Yellowhead 16, the shoreline of Morse Basin, the viewpoint of Butze Rapids, and the shoreline at Fern Passage. With the exception of the bridge at Galloway Rapids, the highway should be easy to avoid along the entire corridor. At the bridge, the new transmission line should cross on the east side, where the existing 69 kV lines are visible in the foreground.

From the bridge the new line should follow the existing right-of-way leading to Hospital Cove, then northward along a proposed new road through a planned residential development area. In the vicinity of Butze Rapids, the transmission line should avoid the Point and stay low when passing in front of the Butze Rapids Viewpoint. Within the industrial area north of Butze Point the transmission line should follow existing and proposed streets to Sourdough Bay and Seal Cove.

Overhead transmission lines would degrade the visual quality, on the unspoiled east shore of Fern Passage although wood poles would blend well with the background vegetation. To mitigate the impact, careful consideration should be given to the point of crossing. In general terms, a more southerly crossing will mitigate visual impacts by moving the line away from the proposed waterfront park at Seal Cove and toward the industrial area at Grassy Bay. Consideration should also be given to a crossing of Fern Passage from the point of land south of Grassy Bay.

Recreation - No significant impacts to recreation opportunities within the corridor are expected.

Heritage - Known heritage sites are recorded for Grassy Bay, the south point of Seal Cove, and David Point (on the mainland). Potential impacts may be expected from right-of-way clearing, access road construction, and

structure construction. Route selection should be coordinated with the Heritage Conservation Branch to avoid impacts to heritage sites.

Common Corridor Impacts - The proposed Port Simpson highway would require a bridge spanning Fern Passage from the vicinity of Seal Cove. Such a structure, with a transmission line, would endanger current seaplane operations, and require the relocation of these services. Relocation could be costly and disruptive to the various users of Seal Cove, including the seaplane operators and maintenance services. In addition, a bridge would virtually eliminate boat traffic through Fern Passage. In addition to recreational craft and research vessels (i.e. boats operated by the Department of Fisheries), commercial fishing boats may use Fern Passage if city plans for a new marina at the Prince Rupert Industrial Park are implemented. A draw- or swing-bridge of unknown design would be required to allow these waterway uses to continue. Even a highly-arched bridge would present additional safety hazards in already dangerous waters.

A new bridge and road crossing to the mainland would probably not open new land for development because of the watershed restrictions surrounding Shawatlan Lake. A secondary road could follow Morse Basin's east shoreline south of the watershed reserve, and open limited development near Butze Rapids. However, soil and terrain conditions would restrict the extent of such development. Any road constructed within the watershed would potentially impact the city's water supply through siltation.

Visual impacts would also accompany the common corridor. A bridge and transmission line crossing Fern Passage would be visible from the waterfront at Ritchie Point, Seal Cove, and Sourdough Bay. Road cuts on the mainland shoreline would disrupt the middleground landscape of Fern Passage, which is currently untouched and pristine. Visual impacts would be moderate to severe, depending on bridge design, location, material,

and color. The transmission line would not add significant visual or land use impacts.

5.3 Morse Basin East

Terrain - A low bench, about 400 to 800 m wide, underlain by weakly ridged gneiss bedrock and thin morainal deposits, extends back from the east shore of Morse Basin. Soils are mainly organic, and there are small areas of bog. Steeper areas above the bench are subject to debris slides. By following a route along low ridges about 300 to 400 m back from the shore, most bogs can be avoided, as can areas subject to debris slides.

Vegetation - No significant impacts to vegetation within the corridor are expected.

Forestry - A helicopter logging chart area has been designated at the high elevations above Butze Rapids. A transmission line below this area could affect helicopter logging operation if the transmission line is located too high on the slope. Therefore it is recommended that the transmission line be located close to Morse Basin.

Water Resources - The estuary and mouth of the Shawatlan River is a particularly sensitive area. However, no impacts would result if a crossing is made at the narrows at the estuary mouth.

Fish - No significant impacts to fish resources within the corridor are expected.

Wildlife - No significant impacts to wildlife within the corridor are expected.

Land Use - No serious problems are anticipated for a transmission line within this corridor. The route could be adjusted to avoid five leased properties on the shoreline of Morse Basin, and an Indian Reserve at the mouth of Shawatlan Lake.

Visual Resources - The potential for adverse visual impact is high particularly in the southern half of the corridor. An overhead line spanning the mouth of Denise Inlet would draw viewer attention from the vista of the inlet, and degrade the visual quality of the location. A ground clearance zone and transmission line on the exposed slopes along Morse Basin's east side would be visible from the Galloway Rapids Bridge, the shoreline at Hospital Cove, proposed residential areas south of Butze Rapids and from boats in Morse Basin. The visual quality in this area is high, but distances to viewing stations exceed 1.5 km. The use of wood poles in this area would blend with the natural vegetation; impacts may range from low to moderate in importance.

A natural topographic bench in the vicinity of Butze Rapids provides good opportunity to screen the transmission line. Consequently, potential visual impacts are considered to be minimal here, as long as the route avoids both the shoreline and the upper exposed slopes above the mouth of Shawatlan Lake.

Recreation - No significant impacts to recreation opportunities within the corridor are expected.

Heritage Resources - No significant impacts to heritage resources within the corridor are expected.

5.4 Denise Inlet - Woodworth Lake

Terrain - This corridor follows the north side of Denise Inlet, and crosses a pass through mountainous terrain between Denise Creek and Woodworth Lake. Bedrock is massive to foliated gneiss, overlain by thin

morainal or colluvial deposits and organic soils.

The path of a major debris flow (not recently active) crosses the corridor just east of the mouth of Denise Inlet. The corridor skirts the large and sensitive estuary of Denise Creek. Barge landings should not be located in this estuary.

Extensive areas of thin, hillslope bog and steep colluvial slopes are encountered in the valleys and pass between Denise Creek and Woodworth Lake. Deep bogs and fens, some too small to map, are located around Bannock and Mahlon Lakes.

A large recent slide above Bannock Lake is exceptional for its size and for the lack of evidence of other slides on this slope. This illustrates the random and unpredictable nature of slides in the region. Other areas of more frequent, smaller slides and debris torrents are found along the corridor (see Map 1).

Climate - Fog and low cloud in the vicinity of Bannock Lake could affect the construction and maintenance of the transmission line if no access road were provided due to watershed concerns.

Vegetation - An extensive bog/bog woodland complex exists in the Mahlon and Bannock Lake area. These bogs are highly sensitive to disturbance and have a high floristic diversity. Avoidance of these areas is difficult since they cross the width of the corridor. Therefore careful construction methods are necessary. Numerous bedrock hummocks occur along the corridor west of Bannock Lake. Structures should be located on the bedrock hummocks with any access road located west of Bannock and Mahlon Lakes.

A well-developed tidal marsh exhibiting three vegetation communities exists at the head of Denise Inlet. The tidal marsh has been rated as highly sensitive because of its diverse vegetation characteristics and

high productivity. While this area will undoubtedly be avoided by access roads and structures, it could be used as a barge landing site for materials. This use should be avoided because of the sensitivity of the tidal marsh habitat.

Forestry - Medium forest sites with mature timber are located along the north side of Denise Inlet. A transmission line should not isolate mature forest stands located above. Therefore the transmission line should be located up the slope so that the timber can be removed using handlogging and A-frame methods. A distance of approximately 1/2 km from the shoreline would probably be sufficient.

Water Resources - The portion of the corridor from Mahlon Lake north lies in the Prince Rupert water supply watershed. Steep slopes above the tributary of Woodworth Lake draining Mahlon Lake must be crossed; construction here could result in sediment being added to the Woodworth Lake reservoir.

Fish - No significant impacts to fish resources within the corridor are expected.

Wildlife - Flood terraces at Denise Inlet have excellent grass, rush and sedge cover for ungulate feeding and waterfowl nesting. The shoreline should be avoided by placing the transmission line at the "slope toe".

Land Use - No significant conflicts with land uses within the corridor are expected.

Visual Resources - The impact of major concern in this corridor involves the crossing of Denise Inlet with overhead lines from the prominent knoll at the inlet's mouth. The transmission lines and clear zones for right-of-ways on both sides of the mouth would be made more obvious if the summit of the knoll was utilized. A recommendation to reduce this impact would avoid the exposed knoll, passing the transmission line

behind (south) of the knoll, and crossing Denise Inlet slightly east of the true mouth. An alternate route that should be considered calls for the transmission line to follow the south shore of Denise Inlet, to a second narrowing of the inlet, approximately one kilometre east at the knoll. An overhead crossing at this point would satisfactorily mitigate potential visual impacts at Denise Inlet.

Recreation - No significant impacts to recreation opportunities within the corridor are expected.

Heritage Resources - No significant impacts to heritage resources within the corridor are expected.

Common Corridor Impacts

The transmission line would share the corridor with the natural gas pipeline. A route for both facilities should be chosen with care to avoid wetland areas and unstable slopes. Impacts on wetlands in the Bannock-Mahlon Lakes area would be reduced by using a single route and access road. An alignment on the west side of both lakes should be considered.

The potential for impacts on the Woodworth Lake watershed is increased by the need for both the pipeline and the transmission line to be built in the watershed. A common right-of-way and access road should be used to minimize clearing of vegetation, and high standards of road construction and revegetation should be employed to reduce the risk of erosion following construction. Both facilities should be built simultaneously to avoid impacts to the watershed in more than one season. If it is necessary, because of rugged terrain, to build structures along a route other than the pipeline route, helicopter construction should be considered to avoid the need for additional spur access roads on steep slopes. Public access to the road should be restricted, not only for public health reasons, but because of erosion to the road and the need

for additional maintenance which can result from unauthorized traffic. Building a dead-end road (i.e. from a barge landing on Denise Inlet, and without bridge access over the Shawatlan River) would eliminate unauthorized access to the road.

5.5 Shawatlan Lake

Terrain - This area is underlain by strongly ridged schist bedrock, with thin surficial deposits and organic soils. No sensitive terrain would be affected.

Vegetation - No significant impacts to vegetation within the corridor are expected.

Forestry - No significant impacts to forestry resources within the corridor are expected.

Water Resources - No significant impacts to water resources within the corridor are expected.

Fish - No significant impacts to fish resources within the corridor are expected.

Wildlife - This corridor segment contains valuable waterfowl nesting habitat. A transmission line route should be chosen to minimize destruction of shoreline and marsh nesting cover on Shawatlan Lake.

Land Use - No significant conflicts with land use within the corridor are expected.

Visual Resources - No important visual impacts are expected within the Shawatlan Lake Corridor, as long as the route remains east of the exposed slope leading to Prince Rupert Harbour.

Recreation - No significant impacts to recreation opportunities within the corridor are expected.

Heritage Resources - No significant impacts to heritage resources within the corridor are expected.

Common Corridor Impacts

Road development parallel to the transmission line would not cause an added problem, since it would cross Morse Basin North of the waterfowl nesting area below Shawatlan Lake.

5.6 Laurier Cove

Terrain - Steep mountainsides must be traversed on both sides of Laurier Cove. There is some risk of slope instability and soil erosion as a result of construction.

Vegetation - The only vegetation constraint in this segment is the tidal marsh at Laurier Cove. This area should be avoided because of its high sensitivity. Several small bogs occur near Scissors Creek which can be avoided by staying to the bedrock ridges.

Forestry - The forests surrounding Laurier Cove contain mature timber on medium forest sites.

Water Resources - Any sediment produced would affect Silver Creek or its estuary. There is some risk of debris flows or torrents down the steep creek channel which enters the north side of the cove.

Fish - Potential impacts at Silver Creek are due to the unstable steep valley sides near the creek's mouth. Development in this area could

create some siltation and slumping problems, reduce spawning habitat, and impede fish migration upstream.

Wildlife - No significant impacts to wildlife within the corridor are expected.

Land Use - No significant conflicts with land use within the corridor are expected.

Visual Resources - Visual impacts in this corridor are expected to be low near Osborne Cove where a relatively flat and thickly forested slope could be used to screen the transmission line. Impacts near Laurier Cove, however, could be substantial due to the exposed steep slopes of the headlands on either side of Silver Creek.
The transmission line would present the lowest visual impact if it kept as close as possible to the shoreline when rounding each of the headlands. An alternate route is available for the southern shoulder, where a narrow bench exists at an elevation of about 80 m. Wood poles would reduce the visibility of the structure, and blend well with the natural vegetation.

Recreation - Access development accompanying the proposed transmission line would have a positive impact on recreation opportunities.

Heritage Resources - Heritage sites are noted for the shorelines of Osborne Cove and Laurier Cove. Exact alignment of a transmission line should be coordinated with the Heritage Conservation Branch to avoid the sites and mitigate damages to sites which cannot be avoided.

Common Corridor Impacts

This corridor segment would be occupied by three linear facilities. Impacts on Silver Creek and its estuary would probably be least if a

causeway and bridge were to be built across the estuary near its mouth, rather than building roads across the slopes on both sides of the estuary and crossing Silver Creek itself. One causeway-bridge crossing should be built for all three facilities. Survey work and initial construction should be serviced by sea access further north and south to avoid unnecessary construction impacts on the estuary or Silver Creek.

The need for all three facilities to cross the steep slope opposite Tuck Point could present geotechnical difficulties, due to the limited space and possible slope instability.

Silver Creek has a high potential for impacts to fish due to the unstable steep valley sides near its mouth. All three facilities together could create serious siltation and slumping problems, reduce spawning habitat, and impede fish migration upstream. If a causeway and bridge are used for the road, care must be taken through construction timing to avoid spawning periods. If this area were traversed by a road and pipeline, the addition of the transmission line would have a negligible effect, unless it was routed over the steep valley sides.

In terms of wildlife impacts, the Silver Creek estuary presents a special problem in choosing the exact alignments of the transmission line, road, and pipeline. The major wildlife concern here is maintaining as much of the south facing forested slope in an undisturbed condition to maximize winter forage.

A common corridor located within the Laurier Cove Corridor would be highly visible and would severely alter the scenic value of the cove. Where a natural setting currently offers an undisturbed vista of the cove, a road and transmission line would interrupt the foreground landscape. Visitors to Laurier Cove would see at close hand disruptive utility developments on three sides. Where possible, use should be made of the thick shoreline vegetation to screen the road and pipeline

rights-of-way from the view of boaters. Natural rock colors and textures should be considered for the finished surface of the causeway-bridge at Silver Creek. The crossing of Silver Creek should be made as far upstream as practicable to reduce the visible expanse of the causeway bridge.

5.7 Tuck Inlet West

Terrain - The west shore of Tuck Inlet has a high concentration of debris slides and torrents, probably related to the weathered schists which dip towards the inlet. Along the northern half of the inlet, steep slopes subject to debris slides would be difficult to avoid and the unstable nature of the bedrock could result in local sliding along road cuts.

Vegetation - No significant impacts to vegetation within the corridor are expected.

Forestry - Mature forests growing on mountain sites cover most of this corridor segment. Because of the relatively high productivity of these sites, these areas should be avoided. Any route alignment in this segment should stay to the higher elevations so as not to alienate timber on the lower slopes and avoid the sites that have better water access and are generally of a higher productivity.

Water Resources - No significant impacts to water resources within the corridor are expected.

Fish - No significant impacts to fish resources within the corridor are expected.

Wildlife - No significant impacts to wildlife resources within the corridor are expected.

Land Use - Potential land use conflicts can be easily avoided within the corridor by routing the line east of the Mount Morse Greenbelt Reserve and west of the small Indian Reserve at the head of Tuck Inlet. Crossing Indian Reserve No. 2 appears to pose no land use conflict, in view of the Port Simpson Band's tentative approval of the use of this corridor.

Visual Resources - Visual impacts within this corridor would be most noticeable where overhead transmission lines would cross Tuck Narrows. Touring boats and recreational craft would have to pass beneath the lines to travel between Tuck Inlet and Prince Rupert Harbour. If Transport Canada requests additional clearance and marking under the Navigable Waters Protection Act, the crossing would be highly visible. Impacts to the visual quality of Tuck Point and Laurier Cove could be great in such a case.

The right-of-way should bisect Tuck Point, avoiding both northern and southern shorelines leading to the Point. In addition, the structure located at Tuck Point should be placed as far west (away from the narrows) as practicable.

Recreation - No significant impacts to recreation opportunities within the corridor are expected.

Heritage Resources - One heritage site at Tuck Point may be impacted by transmission line development. The crossing of Tuck Narrows should be coordinated with the Heritage Conservation Branch to avoid the site.

5.8 Tuck Inlet East

Terrain - Areas of muskeg occur along the bench above the inlet. Impacts could be minimized, however, by using bedrock knolls which outcrop frequently in the muskeg area for structure placement, and by locating

the road to avoid deep muskeg. A transmission line along the knolls would have minimal impact.

Vegetation - A significant bog/bog woodland complex is found in the central portion of the corridor. This area should be skirted along the western edge so there is no interference with upslope drainage patterns. In addition, drainage channels should not be created on the downslope side.

Forestry - No significant impacts to forestry resources within the corridor are expected.

Water Resources - No signficiant impacts to water resources within the corridor are expected.

Fish - No significant impacts to fish resources within the corridor are expected.

Wildlife - No significant impacts to wildlife resources within the corridor are expected.

Land Use - No significant conflicts with land use within the corridor are expected.

Visual Resources - Impacts to the visual landscape in this corridor are expected to be low if existing topographic benches are used to screen the transmission line from Tuck Inlet. On more exposed slopes in the northern half of the inlet, the clear zone should be irregular in width to eliminate the straight lines normally accompanying a linear right-of-way. North of the headwaters of Tuck Inlet, the transmission line should follow the existing logging roads.

Recreation - No significant impacts to recreation opportunities within the corridor are expected.

Heritage Resources - No significant impacts to heritage resources within the corridor are expected.

Common Corridor Impacts

Space is constrained for locating all three facilities along the hillside just north of Tuck Narrows. A road and gas pipeline within this corridor, in addition to a transmission line, would result in more severe visual impacts where terrain benches do not exist, i.e. near Laurier Cove and along the northern half of Tuck Inlet. The width requirements for the three parallel right-of-ways would cause the common corridor to be highly visible on steeper slopes, especially where road cuts would expose existing bedrock or soils. The visual quality of Tuck Inlet would be noticeably degraded by such development. Further feasibility studies are necessary to determine if three linear facilities are practical in this segment and what the best alignments are.

5.9 Georgetown Lake - Port Simpson

Terrain - There are some slopes between Georgetown Lake and Stumaun Creek which are subject to debris torrents and localized slope instability. However, a route following the existing logging road would have minimal impact or exposure to terrain hazards.

Muskeg covers an extensive area south of Neaxtoalk Lake, and sensitive fens and marshes are located along the lake shore, particularly at the northeast end. Impacts on the lake and wetlands would be minimized by a route along the divide north of the lake which separates it from Zumtela Bay, or by crossing the creek below Neaxtoalk Lake near its mouth.

Vegetation - Large expanses of bog/bog woodland occur west of Leading Peak. These areas can be easily avoided by staying east of Lahon Creek along the lower slopes of Leading Peak.

Forestry - No significant impacts to forestry resources within the corridor are expected.

Water Resources - Past logging along Lahon Creek and the west fork of Stumaun Creek has resulted in some erosion of banks and accumulation of sediment and debris in the channels. The creeks are now recovering as natural revegetation proceeds. Further damage is possible from the construction of the transmission line. Impacts could be mitigated by constructing access routes well away from channels, and by reducing the amount of vegetation clearing near the channels.

Fish - The habitat of Stumaun and Lahon Creeks is sensitive to construction activities. Disturbance of spawning habitat could be reduced by bridging the streams prior to construction.

Wildlife - Areas around Stumaun Creek and Lahon Creek are valuable deer and fur-bearer habitat. Impacts could be reduced by routing the line inland so as to skirt the valuable deer winter habitat in the Spruce-Alluvial forest zone. Neaxtoalk Lake possesses a large sedge fringe suitable for waterfowl nesting, and is also valuable habitat for deer winter range. The transmission line should pass to the east of Neaxtoalk Lake to protect these habitats.

Land Use - Because of Port Simpson Band's tentative approval of the transmission line through this corridor, no significant land use conflicts are expected. The line should follow existing roads or proposed linear facilities as closely as possible to minimize the area dedicated to utility use.

Visual Resources - No serious visual impacts are expected within this corridor if the transmission line avoids the exposed slopes of Basil Lump and Leading Peak. The visually sensitive shoreline areas of Stumaun Bay and Neaxtoalk Lake should be easily avoided to reduce the potential for adverse impacts. The right-of-way should make use of a natural ridge southwest of George Hill to screen the transmission line from the potential recreation beaches on the west side of Stumaun Bay.

Recreation - Any road development accompanying the proposed transmission line will have a positive impact on recreation opportunities.

Heritage Resources - No significant impacts to heritage resources within the corridor are expected, if the transmission line avoids the one heritage site at Stumaun Bay.

Common Corridor Impacts

Space would be a constraint at the crossing of the creek downstream from Neaxtoalk Lake. The alternative route northeast of the lake is preferred.

The construction of the transmission line, pipeline, and highway through the valleys of Stumaun and Lahon Creeks has some potential for further damage. Potential impacts can be mitigated by building the main access road well back from the channels, by minimizing vegetation clearing near the channels, and by crossing the creeks with bridges of adequate size and design.

Improper bridging with culvert and rip rap use, along with further channelization by cut and fill construction road building techniques could cause Stumaun and Lahon Creeks to lapse into their former state of disarray. Previous logging damage indicates that these two creeks are easily disturbed. If this corridor segment is chosen, streams should be

bridged prior to construction to prevent further damage. Stream banks should be immediately revegetated in any areas denuded by the use of heavy equipment. The use of a common corridor and simultaneous construction in this area would reduce spawning habitat degeneration by lowering the duration of disturbance by heavy machinery.

Parallel right-of-ways for road, pipeline and transmission line may cause excessive alienation of Stumaun and Lahon Creeks. If this corridor were chosen, impacts could be reduced by combining right-of-ways to reduce the overall cleared area. Also, the route should be placed inland enough to skirt the valuable deer winter habitat in the Spruce-Hemlock forest zone. It would also be advisable to combine all three facilities to the east of Neaxtoalk Lake to protect these habitats and the recreation potential of the lake. Neaxtoalk Lake possesses a large scirpus fringe, suitable for waterfowl nesting. This area also is valuable deer winter range.

Land use and socioeconomic impacts accompanying the pipeline and highway are estimated for Port Simpson in the "Impact Study, Western LNG Project, Volume 2, Socioeconomics and Resource Use", by Read Environmental and Planning Associates. Visual impacts of a common corridor within the Georgetown Lake-Port Simpson alternative are likely to be low if an existing logging road is followed from Georgetown Lake to Stumaun Bay. The greatest potential for impact exists at Neaxtoalk Lake, where a road, pipeline, and transmission line could severely disrupt the scenic qualities of the potential recreation spot.

5.10 Work Channel

Terrain - A number of steep slopes are traversed throughout this corridor; however, there is much less evidence of debris slides than in other parts of the study area. Thin organic deposits overlying bedrock (blanket bogs) are widespread on the slopes above Work Channel, with the most sensitive area being the pass between Georgetown Creek and Work

Channel, and the adjacent group of small lakes. Special care should be taken to avoid these bogs and to avoid disrupting the drainage systems which feed them.

Vegetation - Large areas of bog/bog woodlands are found throughout this corridor segment. These represent the largest concentrations of bog/bog woodlands in the study corridors, and show the greatest floristic diversity and possible occurrence of rare or unusual plant species. They are also extremely sensitive to any disturbance that affects drainage patterns. Because of the distribution of this type, complete avoidance would be difficult, as any recommended route would invariably cross a bog/bog woodland area. A route following the shoreline would be the least impacting. However, because the terrain is quite ridged throughout the Work Channel segment, opportunities exist to place structure sites on the higher hummocks and avoid most of the bog areas. Roads would be difficult and expensive to locate throughout most of this corridor segment. Therefore, disturbance of bog/bog woodland types by road development is expected to be minimal.

Forestry - The valley containing Little Georgetown Lake probably contains some of the best forestry sites in the study area, and are easily developed because of the relatively deep soils. Logging is presently being conducted in this area and the older clearcut areas have been reforested with spruce. Alienation of forest land is difficult to avoid in this segment. Any alignment should use existing access routes and remain to either side of the valley bottom on the side slopes. This would avoid the best forest sites, although some forest production would undoubtedly be lost with any route alignment through this segment.

Mature timber or productive forest sites are found at the pass out of the Little Georgetown Creek valley, and near Work Channel. In order to avoid the best forest sites and prevent stand isolation from water

access, the alignment should follow the upper elevations of the corridor in this area (above 300m), approximately 8 km beyond the pass.

Water Resources - No significant impacts to water resources within the corridor are expected.

Fish - No significant impacts to fish resources within the corridor are expected.

Wildlife - No significant impacts to wildlife resources within the corridor are expected.

Land Use - No significant conflicts with land use within the corridor are expected.

Visual Resources - Potential impacts to the Work Channel Corridor segment would be most severe at the high mountain pass leading from Little Georgetown Creek to Work Channel, and along the exposed slopes flanking the southwest side of Work Channel. Because of the elevation and position of the pass, a transmission line may be skylined at this location. Moderate to severe visual impacts are potential along the exposed slopes of Work Channel from the pass to Trail Bay.

Additional study would be needed to avoid skylining at the pass and to make use of the natural screening features along Work Channel. Screening may be possible along half of this route and, if implemented, would reduce the severity of adverse visual impacts. Wood poles would blend with the natural vegetation and mitigate adverse impacts that could not be avoided.

Recreation - No significant impacts to recreation opportunities within the corridor are expected.

Heritage Resources - No significant impacts to heritage resources within the corridor are expected, as long as the shoreline reaches of Work Channel are avoided.

6.0 CORRIDOR EVALUATION

The preceding sections have dealt with the inventory and evaluation of the corridor segments identified along the study corridors. This provided, on a site-specific basis, an evaluation of corridor segments which could be linked in various combinations to form a corridor between Prince Rupert substation and Grassy Point. Normally this stage of analysis would select a preferred corridor. However because the final choice of a corridor to link the Prince Rupert Substation to Grassy Pont will be largely influenced by the location of other facilities, i.e. pipeline and road, the selection of a preferred corridor at this time would be premature. Therefore, all possible corridors will be evaluated and major areas of constraint noted.

The evaluation process uses the overlay method to identify areas of potential impact. The consultants identified areas classed as high sensitivity for each discipline. These areas were overlaid to produce an environmental constraint map (Map 7). After the environmental constraints were mapped, the consultants met in committee to determine the environmental rating classes based on an overall understanding of the types of impacts present and how easily these could be mitigated either by avoidance or mitigation measures. It was agreed that a grouping of 4 or more severe constraints in one area would lead to very severe or severe impacts. However, it was also realized that in some specific areas, mitigation would not be sufficient to prevent very severe or severe environmental impacts. In such cases, one discipline constraint could be rated as very severe or severe. The terms "very severe" and "severe" were thus defined as follows:

> Very Severe - Environments where a transmission line would result in very severe impacts to 4 or more disciplines. To account for the locally perceived importance of land use and visual resources, these disciplines were given added weight in the analysis. Very Severe impacts are considered to be difficult to mitigate.

Severe - Environments where a transmission line would result in severe impacts to at least 2 disciplines. Fish and wildlife habitats considered critical within the context of the study area were also given an increased weight to account for their importance. Severe constraints require careful planning and costly mitigative measures.

6.1 Major Areas of Constraint

No detailed discussion of the individual constraints, their impacts and mitigation measures will be undertaken in this section. These have been discussed in detail in Section 5.0. This section will briefly describe the location of the major areas of constraint, and corridor segment linkages that have the fewest number of constraints.

The Environmental Constraint Map indicates that numerous areas of very severe and severe constraint are found along all corridors. Areas of very severe constraint are found at Laurier Cove, Stumaun Bay, Neaxtoalk Lake, Tuck Point, Fern Passage, and the adjacent uplands. Obviously these areas are focal points where careful planning will be necessary. These areas generally possess significant resources which will be difficult to mitigate. In the case of Fern Passage, conflict with existing land use especially the seaplane base would have a major impact. Numerous heritage sites are found on the shoreline in this area. Laurier Cove contains the highest potential impacts based on the number of constraints within the study area. High visual vulnerability, significant fish resources, critical ungulate winter range and possible slope instability are major constraints in this area. Any construction in this area would have to be well planned. Tuck Point is highly visible from Prince Rupert and has important heritage sites.

Severe constraints are generally related to biophysical resources such as terrain, wildlife, forestry and vegetation. Severe constraints are found throughout the corridors, but concentrations occur at the head of Denise Inlet, Morse Basin East, and the area of Little Georgetown Lake. The high visual vulnerability of the area on the east side of Morse Basin is the reason for its severe rating. The remaining areas were rated as severe mainly as a result of combined biophysical constraints.

6.2 Least Environmentally Sensitive Corridor

Eleven corridor segments were examined in the corridor evaluation process. These could be combined into 12 possible alternate corridors between Prince Rupert substation and Grassy Point. Corridor segments with the least number of environmental and geotechnical constraints as well as the best location for routes in the corridor are described in this section.

Morse Basin West, Morse Basin East and Denise Inlet-Woodworth Lake are similar in their overall number of constraints. Considering common corridor impacts, two options exist. Firstly, Morse Basin West would be preferred if the proposed road were to cross Fern Passage. Although the impact would be severe, the combining of facilities would localize the potential impact. In addition, the only major constraint area is located at Fern Passage, thus confining the impact in this area. If the road were located elsewhere, Denise Inlet-Woodworth Lake segment would be preferred since the pipeline and its access road would be located through this area. Most constraints in the area can be easily mitigated or avoided with judicious routing. Morse Basin East is not generally preferred because of its visual vulnerability from Highway 16. Mitigation would be difficult.

Shawatlan Lake and Laurier Cove segments have no alternative corridors for comparison. Laurier Cove is significant because of its high impacts. However, all transmission line routes and the proposed road and pipeline must cross this area. Careful route planning and detailed mitigation requirements are necessary in this area.

Tuck Inlet East and Tuck Inlet West segments have few environmental constraints. However, a crossing of Tuck Inlet at Tuck Point would have a high visual impact. In addition, Tuck Inlet West has a high slide potential which could be increased with the construction of a transmission line. If slides and/or erosion were to occur, increased environmental impacts are likely. Therefore, Tuck Inlet East becomes the preferred choice with and without common corridor impacts.

The Georgetown Lake-Port Simpson and Work Channel segments are long segments. The Work Channel segment has a concentration of impacts in the area of Georgetown Creek. Productive forest sites which have been planted on crown land occur in the valley. A transmission line through the pass between Georgetown Creek and Work Channel would be skylined and highly visible from Work Channel. The Georgetown Lake-Port Simpson segment has a number of environmental constraints scattered along its length. In most cases, these environmental constraints are localized and can be avoided with careful route selection. Productive forest sites are found in several locations mainly in valley bottoms. No silvicultural investment has taken place in these areas. Other areas of concern include Lahon and Stumaun Creeks and terrain and vegetation constraints near Stumaun Bay. Neaxtoalk Lake is considered an area of very severe constraints. Recreation, wildlife and water are the significant resources of concern.

Because the proposed road and pipeline are expected to follow a route within the Georgetown Lake-Port Simpson segment, and impacts are similar to the Work Channel segment, the Georgetown Lake-Port Simpson segment is preferred.

In summary, the following corridor linkages are suggested:

Given:	Preferred Transmission Line Route Would Be:
Bridge for a Road at Fern Passage	Morse Basin West Shawatlan Lake Laurier Cove Tuck Inlet East Georgetown Lake-Port Simpson
No Bridge, but Pipeline to Woodworth Lake	Kloiya Bay Denise Inlet-Woodworth Lake Laurier Cove Tuck Inlet East Georgetown Lake-Port Simpson

These corridor linkages yield the least environmentally sensitive corridor given the study constraints and mitigation methods suggested.

7.0 RECOMMENDATIONS FOR FURTHER STUDIES

This environmental study focussed on the potential transmission line between Prince Rupert substation and Grassy Point. The data base consisted of literature review, discussions with local specialists and field investigations. During these phases of study a number of areas that require further analysis emerged. Most important in this list of deficiencies is the consideration of common corridor impacts. Common corridor impacts have been evaluated in an overview type analysis, since their consideration is important at any stage of environmental analysis. The lack of exact route location of these facilities and information regarding the construction standards used limited the overall assessment. Consequently, a study should be considered that evaluates all linear facilities on a common basis and suggests mitigation for all facilities.

The individual disciplines also noted areas of deficiency and areas that required special studies. These special studies should take place only in the corridors selected for facility development. These are described below:

Terrain

A geological and geotechnical study should be made of all portions of the selected corridor where slopes subject to possible debris slides are crossed (terrain units 5a and 6a). Particular areas of concern are the valley south of Woodworth Lake, the Bannock Lake area, Laurier Cove, and both shores of Tuck Inlet. If any of these areas are within the preferred route, further study should be made.

A study involving field measurements should be made of winter snow accumulation and wind speeds at the pass between Little Georgetown Lake and Work Channel.

A study should be made of the hydrology of those streams considered of high or moderate sensitivity, which are crossed by the corridors. This should include flow measurement, channel morphology, and design flows.

Wildlife

The wildlife populations and their preferred habitats have not been studied much on the Tsimpsean Peninsula. This lack of data could have a negative impact on wildlife populations if further information is not collected. Two studies are recommended:

1. Critical deer winter habitats on the shoreline and south facing slopes should be further identified and use quantified.

2. Areas of eagle concentrations (nesting and feeding) and Peregrine falcon nesting should be investigated.

Land Use

An important area of further study involves the seaplane base at Seal Cove and the impacts of constructing an overhead transmission line at this point. Investigations should include relocation costs, potential alternate airbase sites, acceptable distance between full seaplane operations and overwater lines, costs of submerging electrical lines, and alternative crossing points within Fern Passage or Morse Basin.

Detailed route studies should be conducted if the Morse Basin West Corridor is selected, to coordinate the alignment of the transmission line within the planned residential property south of Butze Rapids. Coordination should be accomplished with Prince Rupert planners and engineers. Route selection is also critical through all parts of the city's watershed reserve, to reduce the potential for erosion and siltation effects on the water supply.

Visual

Detailed visual analyses are suggested for five landscape units to minimize adverse impacts. Studies should examine alternative route alignments to make use of possible screening features of the topography. The five units include the following:

1. The knoll at the mouth of Kloiya Bay and Denise Inlet.
2. The eastern slopes of Morse Basin, especially the steep slopes in the vicinity of the "elbow".
3. Fern Passage in the vicinity of Seal Cove.
4. Laurier Cove and Tuck Point.
5. The upper slopes of the Work Channel Corridor, especially the Pass, where the transmission line may be skylined.

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APPENDICES

Appendix	A	List of Contacts
	B	Sample Site Form - Terrain
	C	Particle Size Analyses
	D	Terrain Classification Legend and Definitions
	E	Partial List of Plant Species
	F	Stream Classification - Field Check List

APPENDIX A
LIST OF CONTACTS

A. Ackerman, District Conservation Officer, Smithers

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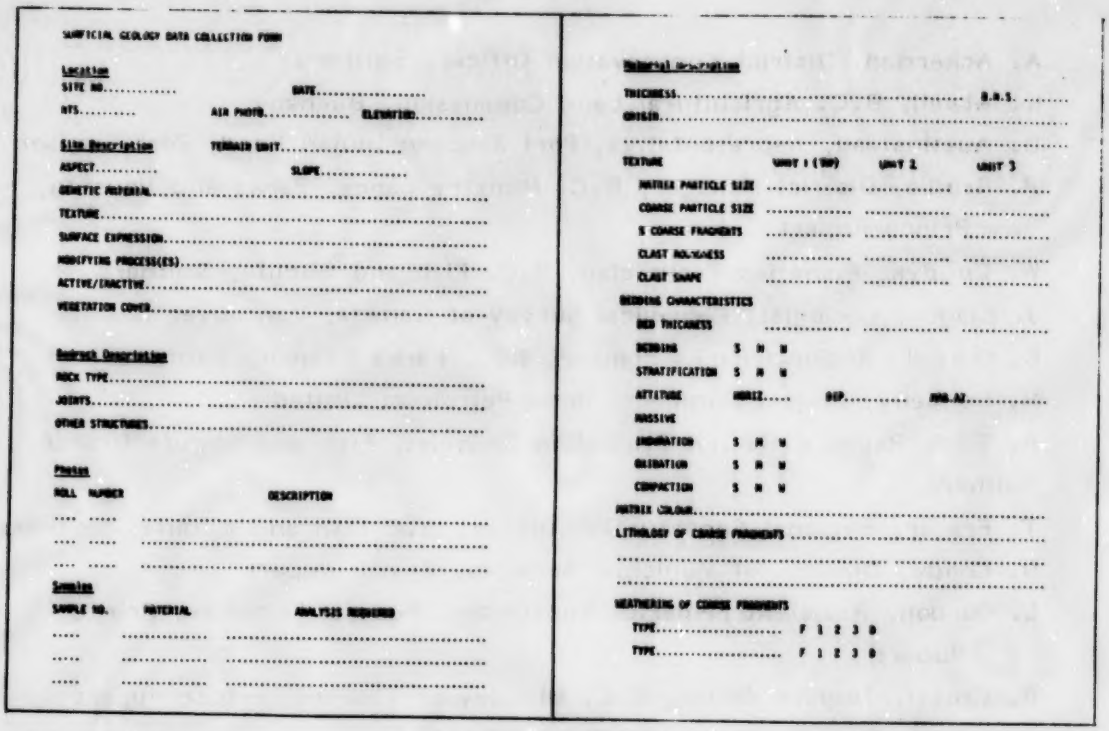
APPENDIX B



SURFICIAL GEOLOGY DATA COLLECTION FORM

Location
SITE NO..... DATE.....
NTS..... AIR PHOTO..... ELEVATION.....

Site Description TERRAIN UNIT.....
ASPECT..... SLOPE.....
GENETIC MATERIAL.....
TEXTURE.....
SURFACE EXPRESSION.....
MODIFYING PROCESS(ES).....
ACTIVE/INACTIVE.....
VEGETATION COVER.....

Bedrock Description
ROCK TYPE.....
JOINTS.....
OTHER STRUCTURES.....

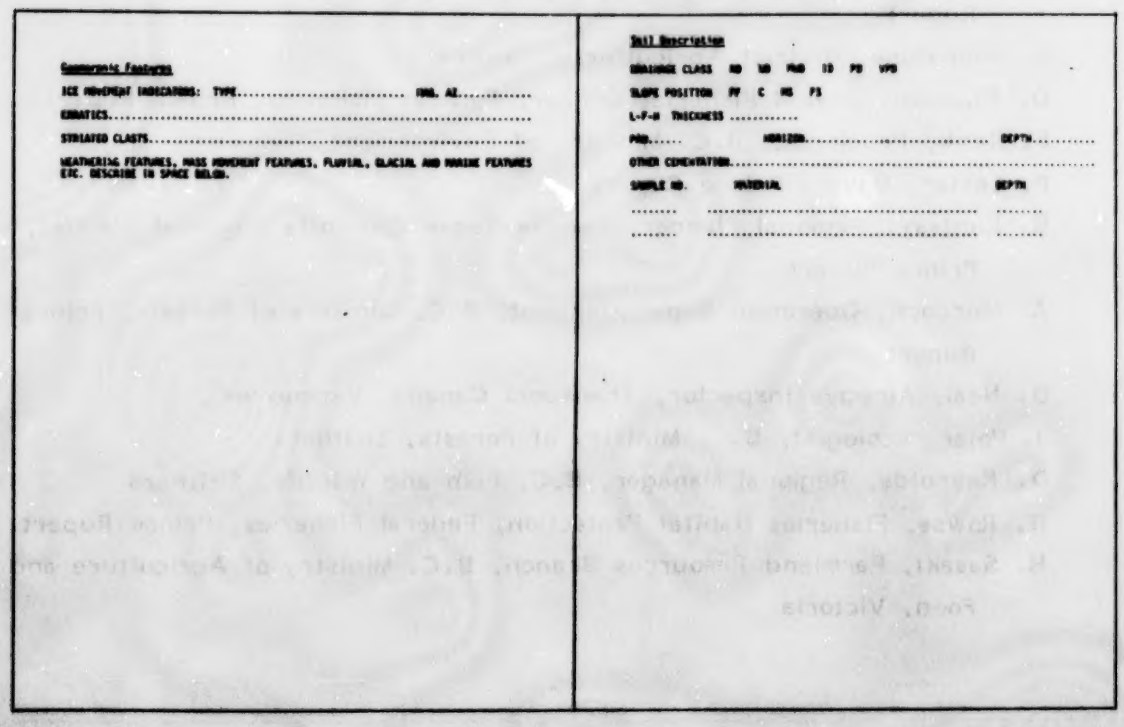
Photos
ROLL NUMBER DESCRIPTION
....
....
....

Samples
SAMPLE NO. MATERIAL ANALYSIS REQUIRED
....
....
....

Material Description
THICKNESS..... B.R.S. .....
ORIGIN.....
.....

TEXTURE	UNIT 1 (TOP)	UNIT 2	UNIT 3
MATRIX PARTICLE SIZE	.....	.....	.....
COARSE PARTICLE SIZE	.....	.....	.....
% COARSE FRAGMENTS	.....	.....	.....
CLAST ROUNDNESS	.....	.....	.....
CLAST SHAPE	.....	.....	.....

BEDDING CHARACTERISTICS
BED THICKNESS ....
BEDDING S M W
STRATIFICATION S M W
ATTITUDE HORIZ..... DIP..... AVG.AZ.....
MASSIVE
INDURATION S M W
OXIDATION S M W
COMPACTION S M W
MATRIX COLOUR.....
LITHOLOGY OF COARSE FRAGMENTS .....
.....
.....
WEATHERING OF COARSE FRAGMENTS
TYPE..... F 1 2 3 0
TYPE..... F 1 2 3 0



Geomorphic Features
ICE MOVEMENT INDICATORS: TYPE..... AVG. AZ.....
ERRATICS.....
STRIATED CLASTS.....
WEATHERING FEATURES, MASS MOVEMENT FEATURES, FLUVIAL, GLACIAL AND MARINE FEATURES ETC. DESCRIBE IN SPACE BELOW.

Soil Description
DRAINAGE CLASS RD WD MWD ID PD VPD
SLOPE POSITION FP C MS FS
L-F-H THICKNESS .....
PED..... HORIZON..... DEPTH.....
OTHER CEMENTATION.....
SAMPLE NO. MATERIAL DEPTH
....
....

APPENDIX C. Particle Size Distribution of Samples

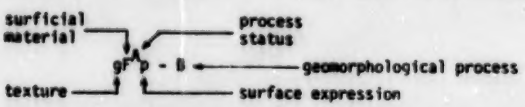
Sample	Location	Material	Terrain Unit	Material Under 2 mm(%)[b] Sand	Silt	Clay	Coarse[c] Fraction(%)	Organic[d] (%)	Remarks
1	Hillslope above Lahon Cr. 090433	Shallow schist-derived colluvium	5	68	19	13	15	8	Includes B-horizon material. Abundant mica.
2	Hwy 16, 4 km south of Pr. Rupert. 173166	Deposits from recent debris slide	6a	65	19	16	19	7	Debris includes abundant woody material.
3	Hwy 16, 6 km south of Pr. Rupert. 174151	Till	1a	69	24	7	15	0	
4	Ridley Island access road 103134	Glacio-marine Till	1b	61	27	12	23	0	

Notes:
a. Grid reference from 1:50,000 maps given.
b. Proportion of fine fraction (<2 mm) using Wentworth system: Clay <4 mm, Silt 4 mm-62.5mm, Sand 62.5mm-2mm.
c. Proportion of total inorganic material in sample. Material in field also includes cobbles and boulders which were not included in sample.
d. Proportion of original sample lost on digestion with hydrogen peroxide.

APPENDIX D

TERRAIN CLASSIFICATION SYSTEM FOR 1:50 000 SCALE MAPPING (1982)

Terrain Unit Symbol



Texture

specific clastic terms:

- c clay
- ɸ silt
- s sand
- p pebbles
- k cobbles
- b boulders
- r rubble
- a blocks
- m mud
- g gravel

general clastic terms:

- f fines
- z chiefly sand
- q chiefly gravel
- d diamicton
- x angular fragments

organic terms:

- e fibric
- n mesic
- h humic
- y shelly

Surficial Material

- A Anthropogenic material
- C Colluvium
- D Disintegrated bedrock
- E Eolian sediments
- F_G Fluvial sediments
- F^G Glaciofluvial sediments
- I Ice
- L_G Lacustrine sediments
- L^G Glaciolacustrine sediments
- M Till
- O Organic sediments
- R Bedrock
- S Decomposed bedrock
- U Undifferentiated sediments
- V Volcanic material
- M_G Marine sediments
- M^G Glaciomarine sediments

Surface Expression

- a moderate slope
- b blanket
- c cone
- d depression
- f fan
- h hummocky topography
- j gentle slope
- m rolling topography
- p plain
- r ridged topography
- s scarp slope
- t terraces
- u undulating topography
- v veneer
- w mantle of variable thickness

Geomorphological Process

- C Cryoturbation
- N Nivation
- S Solifluction
- T Thermokarst processes
- X Frozen ground
- B Braiding channel
- I Irregularly sinuous channe
- J Anastamosing channel
- M Meandering channel
- K Karst processes
- P Piping
- D Deflation
- V Gullying
- L Washing
- E Erosion by running water
- W Wet terrain
- F Slow mass movement
- R Rapid mass movement
- A Avalanching

subclasses of mass movement:

- c soil creep
- q rock creep
- k tension cracks
- p lateral spread (bedrock)
- j lateral spread (unconsolic
- e earthflow
- u slump (unconsolidated)
- ue slump-earthflow
- m slump (bedrock)
- s debris slide
- r rockslide
- f debris fall, topple
- b rockfall
- d debris flow
- t debris torrent

Composite Units

* separates equal components

/ separates unequal components

Examples: gFt * gFf means gFt and gFf are of equal extent

gFt / gFf means gFt is more extensive than gFf (e.g. 60:40 or 70:30)

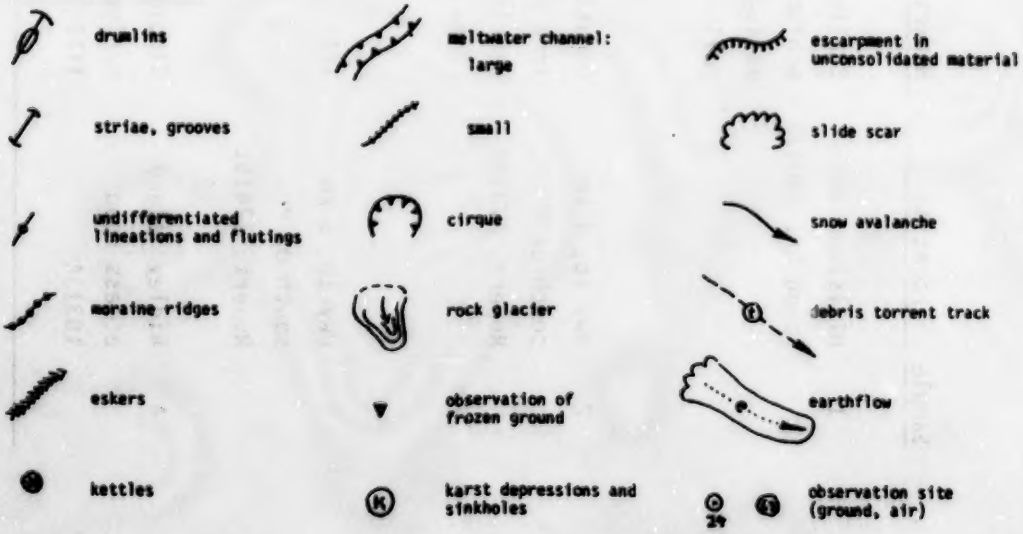
Stratigraphic Symbols

Example: $\frac{gFt}{fL}$ means fluvial gravels that constitute a terrace overlie lacustrine silts

Terrain Unit Boundary Lines

definite, indefinite, assumed or inferred

On-site Symbols (selected)



APPENDIX D (Continued)

Terrain Classification Used for Prince Rupert to Port Simpson Transmission Line Mapping

The following revisions were made to the accompanying terrain legend:

1. Two levels of boundary were used, definite and indefinite.

2. The symbol "/" is used before a component to indicate "discontinuous", e.g. "/Mv" means "discontinuous morainal veneer", or a veneer which occurs over about 1/3 to 2/3 of the underlying unit.

3. Mass movement symbols are as shown on the legend to Map 1.

Definitions for Mass Movement Features

Debris Slide: Rapid downslope movement of a mass of unsaturated, unconsolidated material along a well-defined slip plane.

Debris Avalanche: Rapid downslope flow of a mass of saturated, unconsolidated debris on a steep slope.

Debris flow: A flow of saturated debris that possesses a high degree of fluidity.

Debris Torrent: Rapid flow of a slurry containing rock fragments and vegetative debris along a steep, well-defined stream channel.

(Source: Ryder, 1981.)

APPENDIX E. Partial List of Plant Species in the Study Corridors.

SCIENTIFIC NAME	COMMON NAME
TREE	
Chamaecyparis nootkatensis	Yellow Cedar
Thuja plicata	Western Red Cedar
Picea sitchensis	Sitka Spruce
Pinus contorta	Shore Pine
Tsuga heterophylla	Western Hemlock
Alnus rubra	Red Alder
SHRUB	
Juniperus communis	Common Juniper
Myrica gale	Sweet Gale
Empetrum nigrum	Black Crowberry
Oplopanax horridus	Devil's Club
Andromeda polifolia	Bog-Rosemary
Gaultheria shallon	Salal
Ledum groenlandicum	Common Labrador Tea
Menziesia ferruginea	Rusty Pacific Menziesia
Vaccinium alaskaense	Alaskan Blueberry
V. ovatum	Evergreen Huckleberry
V. oxycoccus	Bog Cranberry
V. parvifolium	Red Huckleberry
V. uliginosum	Bog Blueberry

APPENDIX E. Partial List of Plant Species in the Study Corridors. (Continued).

SCIENTIFIC NAME	COMMON NAME
V. vitis-idaea	Mountain Cranberry
Linnaea borealis	Northern Twinflower
Sambucus racemosa	Coastal American Red Elder
HERBS	
Lycopodium annotinum	Stiff Club-Moss
Equisetum fluviatile	Swamp Horsetail
Adiantum pedatum	Northern Maidenhair Fern
Athyrium filix-femina	Common Lady Fern
Blechnum spicant	Deer Fern
Cryptogramma crispa	Parsley Fern
Monotropa uniflora	Indian-Pipe
Glaux maritima	Sea-Milkwort
Gentiana douglasiana	Swamp Gentian
Menyanthes trifoliata	Buckbean
Fauria crista-galli	Deer Cabbage
Plantago maritima	Sea Plantain
Triglochin maritimum	Sea-side Arrow-grass
Potamogeton natans	Floating-Leaved Pondweed
Juncus effusus	Tawny Common Rush
Luzula parviflora	Small-Flowered Wood-rush

APPENDIX E. Partial List of Plant Species in the Study Corridors. (Continued).

SCIENTIFIC NAME	COMMON NAME
Carex livida	Pale Sedge
C. lyngbyei	Lyngbye's Sedge
C. obnupta	Slough Sedge
C. pauciflora	Few-Flowered Sedge
C. pluriflora	Many-Flowered Sedge
C. sitchensis	Sitka Sedge
Dryopteris austriaca	Wood Fern
Gymnocarpim dryopteris	Oak Fern
Polypodium glycyrrhiza	Licorice Fern
Polystichum munitum	Western Sword Fern
Claytonia sibirica	Siberian Spring Beauty
Nuphar lutea	Yellow-Pond Lily
Caltha palistris	Yellow Marsh-Marigold
Coptis trifolia	Three-Leaved Goldthread
Drosera rotundifolia	Round-Leaved Sundew
Tiarella trifoliata	Trifoliate-Leaved Foamflower
Potentilla palustris	Marsh Cinque-Foil
Rubus chamaemorus	Cloudberry
Rubus pedatus	Five-Leaved Creeping Raspberry
Rubus spectabilis	Salmonberry
Sanguisorba officinalis	Great Burnet
Cornus canadensis	Canadian Bunchberry

APPENDIX E. Partial List of Plant Species in the Study Corridors. (Continued).

SCIENTIFIC NAME	COMMON NAME
Eriophorum angustifolium	Cottongrass
Rhyncospora alba	White-topped Beak-rush
Agrostis aequivalvis	Alaska Bent Grass
Calamagrostis canadensis	Bluejoint Small Reed Grass
Deschampsia caespitosa	Tufted Hair Grass
Glyceria occidentalis	Western Manna Grass
Lysichitum americanum	American Skunk Cabbage
Maianthemum dilatatum	False Lily-of-the-Valley
Streptopus amlexifolius	Cucumberoot Twisted Stalk
Tofieldia glutinosa var. intermedia	Sticky False Asphodel
Veratum viride	Green False Hellebore
Habenaria sacata	
Platanthem dilatata	Fragrant White Reid Orchid
Listera cordata	Heart-Leaved Twayblade
MOSSES	
Dicranum strictum	
Stokeisella oreganum	
Hylocomium splendens	
Mnium glabrescns	
Pleurozium schreberi	
Sphagnum spp.	
LICHENS	
Cladina spp.	
Cladonia spp.	

APPENDIX F

STREAM CLASSIFICATION - FIELD CHECK LIST

Name_____ Date_____ Section_____ km above mouth

Estimated discharge_____ Water quality_____ Temperature_____

A. Terrain at section:
- 1 mountainous
- 2 hilly
- 3 stream-cut valley in plateau or wide valley
- 4 wide valley bottom
- 5 alluvial fan in larger valley

Watershed area_____

Comments

B. VALLEY BOTTOM AND FLANKS

Vertical relation of channel to valley bottom:
- 0 not applicable
- 1 not obviously degrading or aggrading
- 2 partly incised/entrenched
- 3 incised/entrenched
- 4 aggrading

Lateral relation of channel to valley walls or high resistant terraces:
- 0 not applicable (no valley or free)
- 1 occasionally confined
- 2 frequently confined
- 3 confined
- 4 incised/entrenched

Failure of valley walls:
- 0 none or not applicable
- 1 occasional
- 2 frequent

Type of failure:_____

Terrace presence:
- 0 none
- 1 indefinite
- 2 fragmentary
- 3 continuous

Floodplain:
- 0 none
- 1 indefinite
- 2 fragmentary
- 3 continuous

Vegetation on valley bottom:
- 0 none or not applicable
- 1 alpine
- 2 muskeg/wetland
- 3 grassland
- 4 cultivated
- 5 forested

Number of terrace levels:_____

Flood zone width: _____

Land use:
- 0 not developed; inaccessible
- 1 not developed; accessible
- 2 cultivated
- 3 logging
- 4 built-up

Development along route:
- 0 none
- 1 pipeline
- 2 highway
- 3 railway
- 4 other_____

Comments: _____

C. CHANNEL

Channel pattern:
- 1 straight
- 2 sinuous
- 3 irregular
- 4 irregular meanders
- 5 regular or tortuous meanders
- 6 frequent islands
- 7 split
- 8 braided

Type of flow:
- 0 not obvious
- 1 uniform water surface
- 2 uniform with rapids
- 3 uniform with boils and irregularities
- 4 pool and riffle sequence
- 5 tumbling flow

Natural obstructions:
- 0 none apparent
- 1 logs
- 2 beaver dams
- 3 boulders (log)
- 4 vegetation

Bar type:
- 0 none
- 1 channel side bars
- 2 point bars
- 3 channel junction bars
- 4 mid-channel bars
- 5 diagonal bars
- 6 sand waves or large dunes

Bank material:
- 0 fluvial/alluvial
- 1 colluvial
- 2 fluvio glacial
- 3 lacustrine
- 4 morainal
- 5 organic
- 6 bedrock

Processes of bank failure:
- 0 none apparent
- 1 fall
- 2 creep
- 3 flow
- 4 slump
- 5 undercutting

Lateral activity:
- 0 not detectable
- 1 downstream progression
- 2 progression and cut-offs
- 3 cut-offs
- 4 entrenched loop development
- 5 irregular lateral activity
- 6 avulsion

Lateral stability:
- 0 stable
- 1 slightly to moderately unstable
- 2 highly unstable

Depth of alluvium:
- 0 no alluvium
- 1 shallow (less than 2 m)
- 2 variable
- 3 deep (more than 2 m)

Predominant bed material (Wentworth classes):
- 0 not apparent
- 1 sand or finer
- 2 gravel
- 3 cobble or coarser

Bank stabilization:
- 0 none
- 1 vegetation
- 2 armouring
- 3 bedrock
- 4 other_____

Bedrock outcrops in channel bed:
- 0 none detectable
- 1 occasional
- 2 frequent

Comments: _____

MAPS NOT

FILMED

CARTES

OMISES